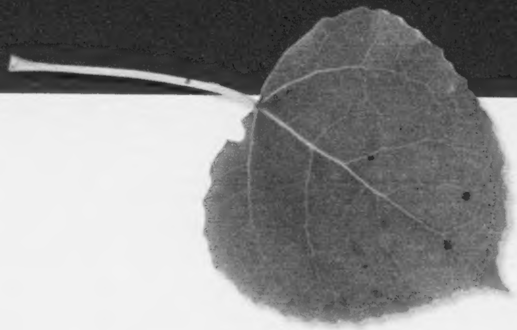
Ontario Ministry of Natural Resources

Ontario

State of Ontario's Forests

Natural. Valued. Protected.



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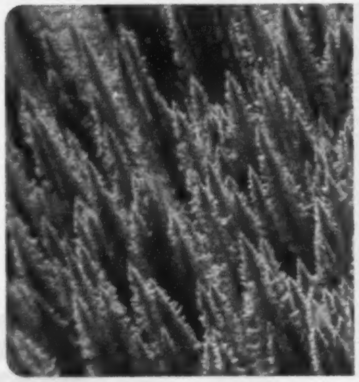
About this report

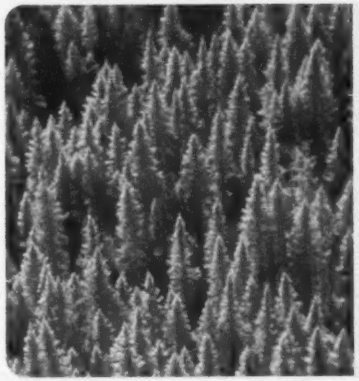
The State of Ontario's Forests report may be accessed electronically at: http://www.ontario.ca/forestreporting. Electronic versions of the report may be viewed using the tabs along the right hand side of the screen to navigate between sections. Buttons are included at the beginning of most sections of the report to navigate within the section. The yellow home tab in the upper right hand corner of the screen navigates to the beginning of the report.

This section of the report provides an overview through an executive summary, an introduction, forest facts, and an introduction to Ontario's forests.



Executive Summary

Highlights from the State of Ontario's Forests report.

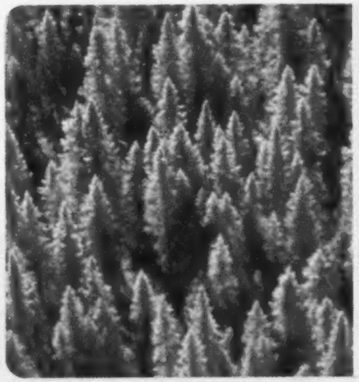


Introduction

A brief look at forest legislation in Ontario, and the context for this report.

Forest Facts

Some interesting facts about Ontario's forests.



Ontario's Forests

A high level overview of Ontario's forests, describing the amount and varying types of forest.

Executive Summary

Ontario's forests provide a variety of environmental, economic, and social benefits to the people of Ontario. The Ministry of Natural Resources has a mandate to manage forests in a sustainable manner to ensure they continue to provide benefits to future generations.

A hierarchical criterion and indicator (C&I) framework is used to assess the state of Ontario's forests. The framework consists of criteria at the highest level, followed by elements, and indicators.

This report is the third State of Ontario's Forests (SOF). The SOF report focuses primarily on the period April 1, 2004 through March 31, 2009 (fiscal years 2004 through 2008). Portions of the SOF report use data from outside the reporting period. In some instances this is due to specific data sets not corresponding to the reporting period. Where information was available beyond the 2004 to 2008 period it was used to enhance trend analysis and to improve the utility of the SOF report. The reporting approach has evolved to include this feature SOF report and a supporting C&I website.

The feature SOF report focuses on specific themes (state of the forest sector, biodiversity, forest health, and climate change) and provides a high-level summary of the SOF C&I framework. The C&I website provides detailed information about the C&I framework and will be updated periodically to provide new information prior to the release of the next SOF report.

Ontario's forest sector experienced a major economic downturn from 2004 to 2008, resulting in the following:

- Annual harvesting levels dropped by 10 million cubic metres (43%) over the five year period
- While employment levels increased from 2001-2004, forest sector jobs were lost at an average rate of 11% per year from 2001-2006
- Estimated operating surpluses (a measure of profitability) decreased by approximately $1.1 billion (57%) in the wood products sector and $814 million (29%) in the paper manufacturing sector over the five-year period

Provincially funded initiatives worth over $660 million were implemented to revitalize the forest sector.

Executive Summary

Biodiversity provides people with a variety of essential ecosystem services (e.g., raw materials, flood prevention, climate regulation, and soil formation). While a number of factors threaten biodiversity in Ontario (e.g., habitat loss, invasive species, pollution, unsustainable use, and climate change), the indicators related to forest biodiversity were relatively stable from 2004 to 2008.

The amount and type of forested area was relatively stable in the area of the undertaking (the portion of the province where forest management is permitted on Crown land subject to the conditions outlined in the Class Environmental Assessment Approval) from 2004 to 2008. Forest fragmentation levels (i.e., how broken up or dispersed forests are on the landscape) were also stable in the area of the undertaking while a trend to fewer, smaller, and more fragmented forests was evident in southern Ontario.

From 2004 to 2008, over 167,000 hectares were added to parks and protected areas. As of 2009, parks and protected areas covered nearly 10% of Ontario's land mass.

Wildlife population monitoring revealed that populations remained stable. White-tailed deer, moose, and pileated woodpecker populations were stable. American marten population levels varied across its range. Migratory forest bird surveys showed declines in some species. Short-term trends in resident bird species (non-migratory) did not change noticeably. Small mammal populations exhibited typical high year-to-year variation.

Minor fluctuations were observed in the number of forest-associated species of conservation concern. Between 2005 and 2010, nine new species were added (deteriorating), 67 species were removed (improving), 13 species were down-listed (improving), 14 species were up-listed (deteriorating), and the conservation status of 819 species did not change. Most of the changes were attributable to improved data rather than actual changes in the abundance of species.

The threat of invasive species continued to grow. A number of non-native plants, insects, and diseases threaten Ontario's forests and are considered invasive. Some of the species (e.g., kudzu and dog-strangling vine) are highly invasive. Efforts continued to minimize the introduction of invasive species into Ontario's forests.

In a managed forest, forest harvesting and the associated renewal activities are important for maintaining forest health. The downturn in the forest sector resulted in reduced harvesting and renewal levels. Over the long-term, reduced harvest levels combined with forest fire management activities could result in a shift to artificially old forests which could affect the achievement of forest health objectives.

While forest harvesting and renewal levels declined, renewal efforts exceeded harvest levels. From 2004 to 2008, the average annual area regenerated was 202,947 hectares, which was approximately 13% higher than the average annual harvest area. The reliance on natural renewal increased, resulting in a corresponding decrease in the amount of some assisted renewal activities.

Executive Summary

From 2004 to 2008, nearly 230,000 hectares were assessed annually to determine the success of the renewal treatments. Ninety-one percent of the areas assessed were identified as having been renewed.

Average temperatures across Ontario have increased by 1.4°C since 1948. These changes, combined with increased extreme weather events forecast to occur as a result of climate change, are expected to affect the composition, structure, and function of Ontario's ecosystems. The MNR is assessing the vulnerability of Ontario's forests to climate change. Understanding the adaptive capacity of our forests and examining the need for our assistance in helping species adapt will be crucial to ensuring the future health and resilience of our forests.

In addition to affecting where tree species can grow, climate change is expected to increase the number of fires, extreme weather events, insect outbreaks, and invasive species introductions. From 2004 to 2008, the number of fires, weather events, and insect outbreaks were relatively low compared to previous periods.

The mountain pine beetle outbreak in western Canada is linked to a warming climate. As of 2010, the mountain pine beetle was established in central Alberta and had spread from lodgepole pine to jack pine. If the mountain pine beetle were to spread into Ontario it could have major implications for Ontario's forests.

Ontario's forests have the potential to be either a carbon source (release more carbon than they store) or a carbon sink (absorb more carbon than they release). As trees grow, forests remove carbon dioxide from the atmosphere by plant photosynthesis. Forests also contribute carbon to the atmosphere through decomposition as tree mortality occurs. In 2010, six billion tonnes of carbon were estimated to be stored in Ontario's Crown managed forests. From 2010-2030, Ontario's Crown forests are expected to be a net source of carbon before becoming a carbon sink from 2040 until the end of the century. The change from a carbon source to carbon sink is due to changes in the age structure of the forest.

At nearly 50% carbon by dry weight, trees store considerable amounts of carbon. Increasing the amount of forest cover therefore increases the amount of carbon sequestered from the atmosphere. During the reporting term, annual deforestation levels (the conversion of forested area to non-forested area) exceeded afforestation (the conversion of non-forested area to forested area) levels. From 2001 to 2007, the annual deforestation level was 0.05% of the total forested area in the area of the undertaking and 0.06% of the total forested area in southern Ontario. The implementation of the 50 Million Tree Program in southern Ontario is expected to increase afforestation levels during the next reporting period.

The MNR is assessing the potential of Ontario's forests to mitigate greenhouse gas emissions through their ability to store carbon. This work includes assessing continued carbon storage in wood products made from harvested trees. Further research and analysis are required to determine the mitigation potential of these activities at the landscape and stand level.

While a number of the aspects of sustainable forest management in Ontario were positive, other aspects exhibited room for improvement. The condition of Ontario's Crown forests in the area of the undertaking was generally unchanged from that reported in SOF 2006.

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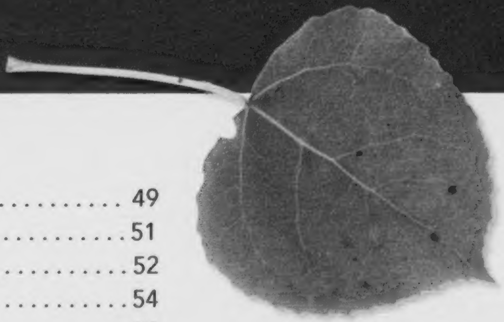

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Introduction

Ontario's forests are immensely important to the environmental, economic, and social well being of the people of Ontario. Ontario's forests also make important contributions to global ecological cycles. Sustainable Forest Management (SFM) is the foundation on which the Ministry of Natural Resources (MNR) manages and monitors forests to ensure they are available for the enjoyment and use of future generations.

In Ontario, three principle mechanisms are used to achieve SFM:

- A comprehensive system of legislation, regulations, policies, and technical guides that promote public consultation and sustainable resource management
- A forest management planning system that requires an evaluation of progress towards achievement of SFM at several stages of implementation
- A compliance program and a system of third party independent forest audits to monitor the implementation of SFM

The evaluation of forest sustainability at a provincial level through the State of Ontario's Forests (SOF) report builds on the evaluation of sustainability that occurs through the mechanisms described above.

The SOF report addresses legal requirements from the *Crown Forest Sustainability Act* (CFSA) and the *Declaration Order regarding MNR's Class Environmental Assessment Approval for Forest Management on Crown Lands in Ontario* (Class EA Approval) to report every five years on the state of Crown forests. The SOF report also addresses the provincial assessment of Ontario's forest resources using a criterion and indicator (C&I) framework as required by the *Forest Resource Assessment Policy.*

A hierarchical C&I framework is used to assess the state of Ontario's forests. The framework consists of criteria at the highest level, followed by elements, and indicators. For more details, refer to the summary section of this SOF report.

This report is Ontario's third SOF. The SOF report focuses primarily on Crown forests in the area of the undertaking (AOU) from April 1, 2004 to March 31, 2009 (fiscal years 2004 through 2008). The area of the undertaking is the portion of the province where forest management is permitted on Crown land subject to the conditions outlined in the Class EA Approval (Figure 1). Some of the information in this SOF report applies beyond the AOU and pertains to the entire

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province (e.g., the number of invasive species and species of conservation concern).

Although data are principally sourced from 2004 to 2008, portions of the SOF report describe long-term data trends using information that may originate from outside of the reporting period. In some instances this is due to specific data sets not corresponding to the reporting period. In addition, where information was available beyond the 2004 to 2008 period it was used to enhance trend analysis and to improve the utility of the SOF report.

Previous SOF reports included extensive and detailed information on the entire C&I framework. This SOF provides summarized C&I framework information plus in-depth information on four selected themes. A supporting SOF C&I website, provides detailed information comparable to previous reports and will be updated as newer information is available.

The SOF report consists of five main sections. This section provides an introduction, a list of forest facts, and an overview of Ontario's forests. The second section examines the state of Ontario's forests as they relate to four selected themes - state of the forest sector, biodiversity, forest health, and climate change. The third section provides a summary of the SOF C&I framework. A conclusion is provided in the fourth section and appendices are provided in the fifth.

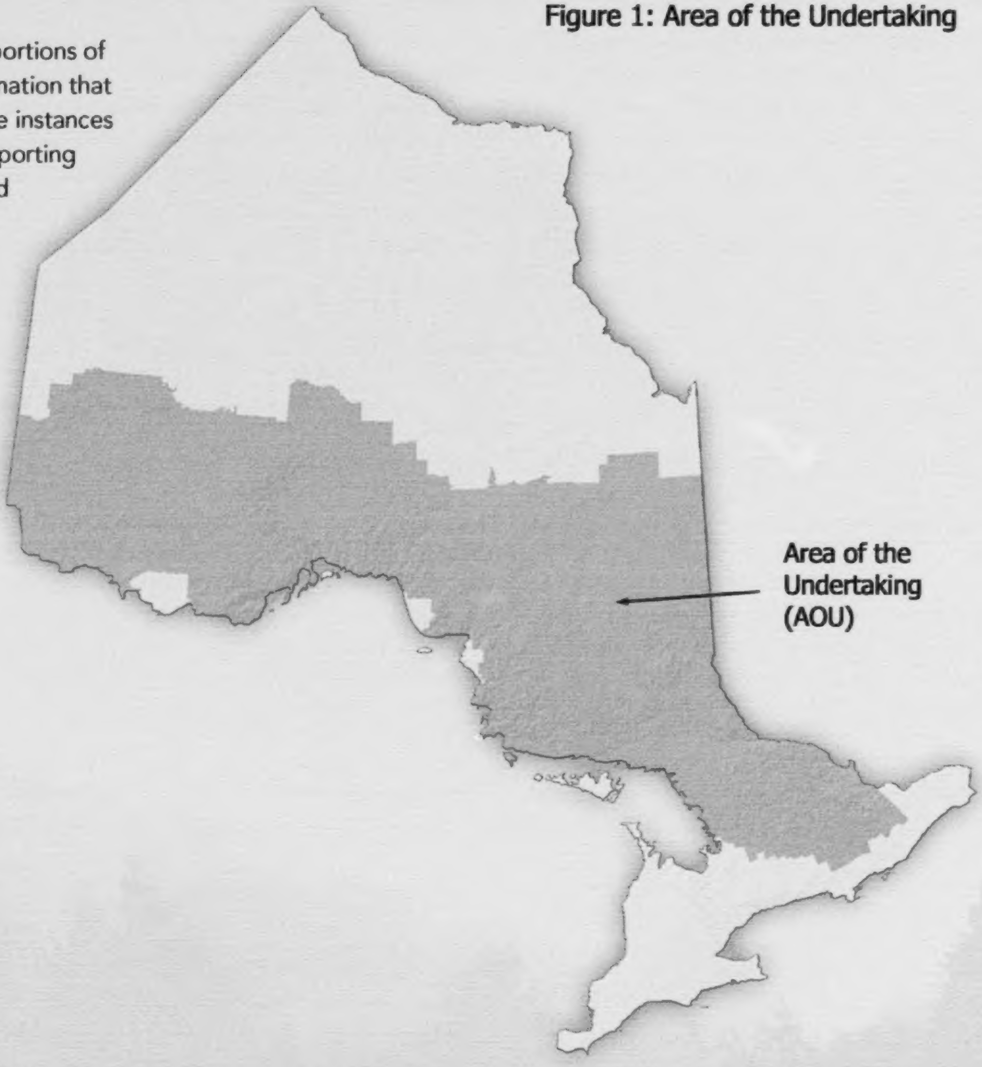
Figure 1: Area of the Undertaking

Introduction

Ontario's Forest Policy Framework

The overall strategic context for forest management in Ontario is defined by the *Policy Framework for Sustainable Forests* (1994). The framework sets broad direction for forest policy and makes forest sustainability the primary objective of forest management programs.

The *Crown Forest Sustainability Act* is the key piece of forestry legislation in Ontario. It provides for the regulation of forest planning, information, operations, licensing, trust funds, processing facilities, remedies, and enforcement. The act also mandates the development of four manuals (*Forest Management Planning Manual for Ontario's Crown Forests*, *Forest Information Manual*, *Forest Operations and Silviculture Manual*, and the *Scaling Manual*) to guide various aspects of forest management in Ontario.

Forest management in Ontario is subject to environmental assessment. Environmental assessment is a legislated decision making process used to promote sound environmental planning. The MNR's management of Crown forests in the area of the undertaking is bound by the conditions of the Class EA Approval.

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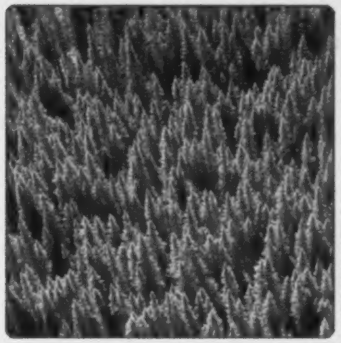
Forest Facts



Ontario's Crown forests are managed in a sustainable manner to ensure long-term forest health while providing environmental, economic, and social benefits to Ontarians. The following facts are excerpts from SOF indicator reports. For more detailed information refer to the corresponding indicator report available on the SOF C&I website. Unless otherwise stated, these facts correspond to the 2004 to 2008 SOF reporting period.

- Weather disturbances caused tree mortality in approximately 866,000 hectares of forests, while fire affected approximately 125,000 hectares (Indicator 2.2.1).
- Insects caused tree mortality in approximately 3.4 million hectares (Indicator 2.2.2).
- In 2010, there were 855 forest-associated plant and animal species of conservation concern (Indicator 1.2.1).
- Over 95 million cubic metres of wood were harvested from nearly 880,000 hectares. Forestry operations and the subsequent manufacturing of forest products generate substantial economic benefits for the provincial economy (Indicator 5.1.4).
- Several plant species were considered invasive in Ontario's forests. Invasive plants, insects, and pathogens may have strong influences on forest structure, species composition, and ecosystem function. When introduced into ecosystems, invasive species can flourish and have the potential to out compete and contribute to the decline or loss of native species (Indicator 1.2.3).
- Approximately four billion tree seeds were collected from 2004 to 2008. One hundred and twenty million tree seedlings were planted annually on Crown land (Indicator 1.3.2).
- The annual average investment (including capital and repair expenditures) in Ontario's forest industry was over $1 billion. The level of investment declined throughout the entire period, corresponding with the decline in the forest products sector (Indicator 5.2.3).
- In 2006, 424 communities in Ontario were considered forest dependent (Indicator 6.2.1).

Forest Facts

- Non-timber forest products (NTFP) add to the value of Ontario's forest products, generating additional jobs and income (beyond traditional wood harvesting operations) from the same forest resource base. As an example, Canada yew is a NTFP harvested for use in cancer treatment drugs (Indicator 5.3.3).
- Resource industries (e.g., forestry and mining) accounted directly for 7.1% of Ontario's jobs. Forest-based resource industries accounted for 1.2% of the jobs in Ontario and provide an above average share of full-time jobs with compensation above the provincial average (Indicator 5.2.2).
- Ontarians spent approximately $4.3 billion annually, and supported 77,900 jobs, through participation in nature-related activities such as wildlife viewing, hunting, fishing, camping, and trapping. (Indicator 5.1.3).
- The MNR developed over 100 courses for forest practitioners. Registration for various types of formal training ranged from 1,100 to 1,800 participants per year (Indicator 7.2.1).
- Over 28,000 inspections of forest operations were conducted by both the forest industry and MNR. The compliance rate was 95% (Indicator 7.4.5).
- Forty-eight independent forest audits (IFAs) were conducted. Compliance with provincial legislation, policies, and guides was 95% (Indicator 7.4.4).

Ontario's Forests

This part of the SOF provides an overview of Ontario's forests. For more detail refer to the *Forest Resources of Ontario 2011* (FRO) available on the MNR's website. The FRO provides detailed information on Ontario's forests including statistics describing the area of land and water, the forest types, and the distribution of tree species across the province. *An Assessment of Ontario's Forest Resources* also provides information on Ontario's forests. Summaries of *An Assessment of Ontario's Forest Resources* are available in the 2001 and 2006 SOFs available on the MNR's website.

The densely populated southern portion of the province contains a mixture of small patches of forest, agricultural lands, and urban areas. Most of the province is dominated by forests, lakes, and wetlands. Forests, both productive and non-productive forested wetland (treed bog and treed fen), make up 66% of the province (Figure 2).

The main forest regions in Ontario are the Hudson Bay Lowlands, the boreal forest, the Great Lakes-St. Lawrence forest, and the deciduous forest (Figure 3). Each of these has unique landscape characteristics and tree species.

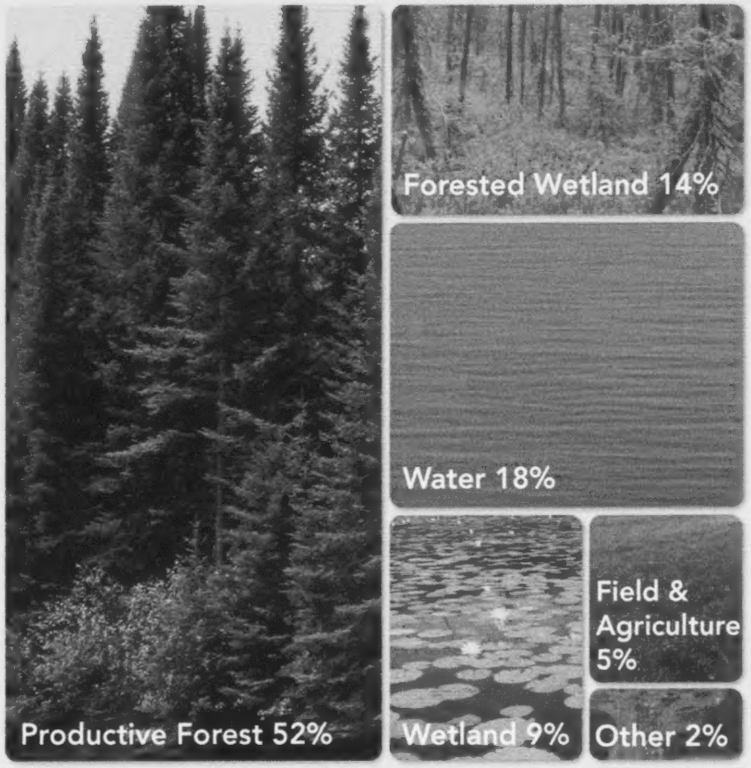
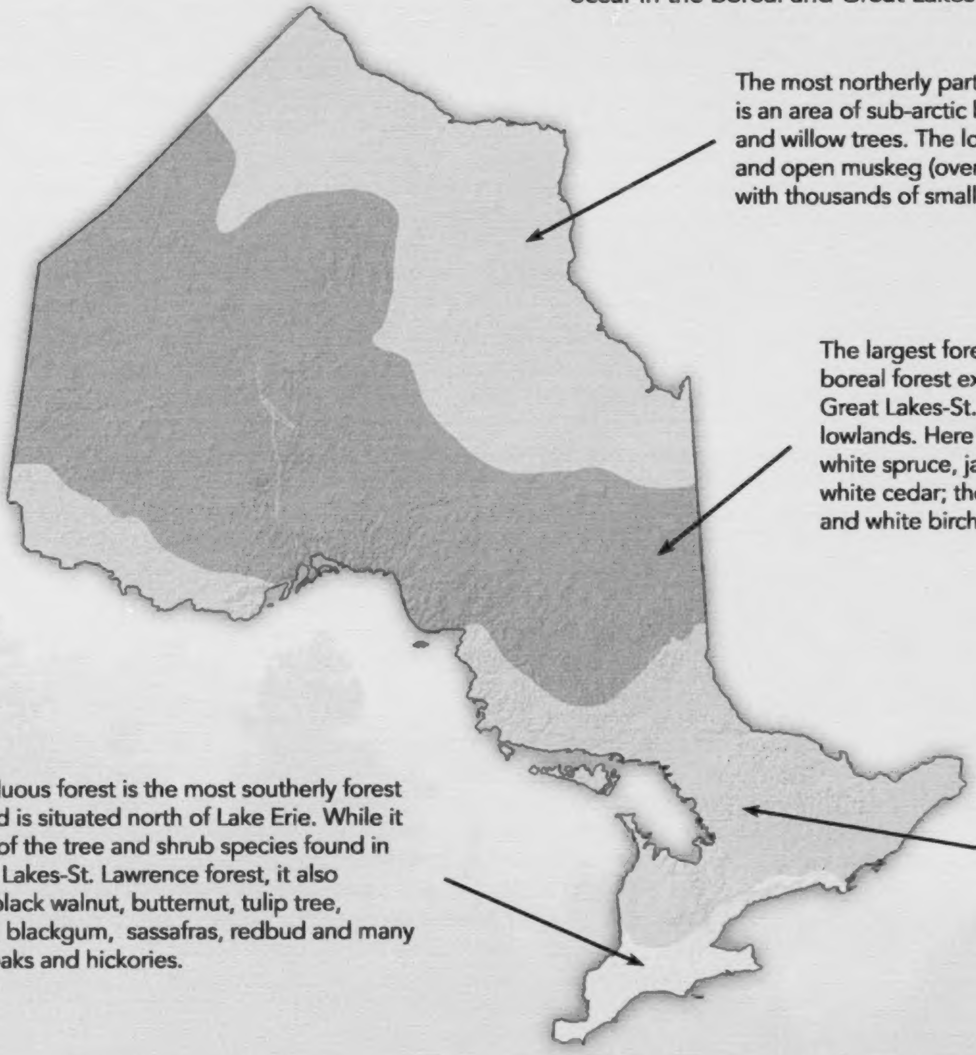


Figure 2: Ontario's land cover classes

Ontario's Forests

Figure 3: Rowe's Forest regions of Ontario



Most forest management activities (harvesting, renewal, and tending) occur in the boreal and Great Lakes-St. Lawrence forest regions.

The most northerly part of Ontario, the Hudson Bay Lowlands, is an area of sub-arctic barrens with black and white spruce and willow trees. The lowlands are dominated by both treed and open muskeg (over two-thirds of its area) and are dotted with thousands of small lakes and ponds.

The largest forest region in Ontario and Canada, the boreal forest extends from the northern limits of the Great Lakes-St. Lawrence forest to the Hudson Bay lowlands. Here the main conifer species are black and white spruce, jack pine, balsam fir, tamarack and eastern white cedar; the dominant deciduous species are poplar and white birch.

The Great Lakes-St. Lawrence forest is the second largest forest region in Ontario. In this region, coniferous trees such as eastern white pine, red pine, eastern hemlock and white cedar, commonly mix with deciduous broad-leaved species, such as yellow birch, sugar and red maple, basswood, and red oak. Species more common in the boreal forest, such as white and black spruce, jack pine, aspen and white birch also exist here.

The deciduous forest is the most southerly forest region and is situated north of Lake Erie. While it has most of the tree and shrub species found in the Great Lakes-St. Lawrence forest, it also contains black walnut, butternut, tulip tree, magnolia, blackgum, sassafras, redbud and many types of oaks and hickories.

Themes

In this section, the state of four themes (the forest sector, biodiversity, forest health, and climate change) related to Ontario's forests are examined. The themes are based on groups of indicators from the SOF C&I framework.

Forest Sector

A look at the state of Ontario's forest sector in terms of economic conditions, bioeconomy development, value-added wood products, and non-timber forest products.

Biodiversity

An examination of the state of biodiversity in Ontario's forests.

Forest Health

An assessment of the factors affecting the health of Ontario's Crown forests including: renewal, insects, invasive species, fires, diseases, and severe weather.

Climate Change

A review of the ability of Ontario's forests to adapt to and help mitigate climate change.

Forest Sector

While Ontario's forests were an important source of lumber for early European settlers, an international conflict on another continent helped launch the province's forest sector. When their main timber supply in the Baltic region was cut off by the French during the Napoleonic wars, the British were forced to look elsewhere for large timbers to maintain and expand their sailing fleet. Ontario's expansive pine forests were found to be a suitable source and, as a result, large-scale commercial logging operations began in the early 1800s.

Since then, Ontario's forest sector has grown and has made significant contributions to the establishment of communities across Ontario. The forest sector generates substantial economic benefits while helping maintain healthy forests. Healthy forests provide a host of social and environmental benefits. Ontario's forest sector was in a major economic downturn for much of the 2004 to 2008 period, beginning in 2005. Prior to the downturn, Ontario's forest sector supported nearly 200,000 direct and indirect jobs across the province. This forest sector theme examines the downturn in the industry and initiatives to revitalize it.

Forest Sector Downturn

Downturns are not uncommon in the forest sector. As with other commodity-based industries, the forest industry fluctuates with economic cycles. The most recent downturn was much more severe than previous declines. A number of factors have contributed to the downturn including:

- The higher value of the Canadian dollar
- Access restrictions to the United States market under the 2006 Softwood Lumber Agreement
- The depressed United States housing industry
- Expansion of digital media resulting in a weakened demand for pulp and newsprint
- Lower cost competitors in the global marketplace
- Higher production costs including energy costs
- The global economic recession

As outlined in the following paragraphs, the downturn in the forest sector was apparent in harvesting levels, employment levels, and forest sector profitability.

Forest Sector

Harvest levels ranged from 23.2 million cubic metres in 2004 (73% of the 32 million cubic metres available for harvest in approved forest management plans) to 13.2 million cubic metres in 2008 (42% of the 31 million cubic metres available for harvest in approved forest management plans). The volume harvested by the forest industry over the past several decades (Figure 4) was well below available levels (Indicator 5.1.4). The shortfall in harvest levels represents a substantial loss of economic, social, and potentially environmental benefits for Ontarians.

According to Statistics Canada census data, the number of forestry-related jobs in Ontario steadily declined. From 2001 to 2006, jobs were lost at an average rate of 10.8% per year. During 2006 and 2007 in particular, thousands of jobs were lost in Ontario's forest sector due to permanent and indefinite mill closures. Most resource-based industries in Ontario showed similar declines in employment levels (Indicator 5.2.2).

Estimated operating surpluses, a measure of profitability, in the paper and wood products manufacturing sectors declined from 2004 to 2008 (Indicator 5.2.1). The wood products manufacturing sector (e.g., sawmills, veneer, plywood, and engineered wood) remained relatively stable from 1999 to 2003 but substantial declines occurred from 2004 to 2008 (Figure 5). In 2004, the estimated operating surplus in the wood products manufacturing sector was $1.9 billion. By 2008, the estimated operating surplus in the wood products manufacturing sector dropped by 57% to $808 million.

Operating surpluses in the paper manufacturing sector (i.e., pulp, paper, paperboard, and converted paper products) have steadily declined since 2000 (Figure 5). In 2004, the estimated operating surplus in the paper manufacturing sector was $2.8 billion. By 2008, it had dropped 29% to $2 billion.

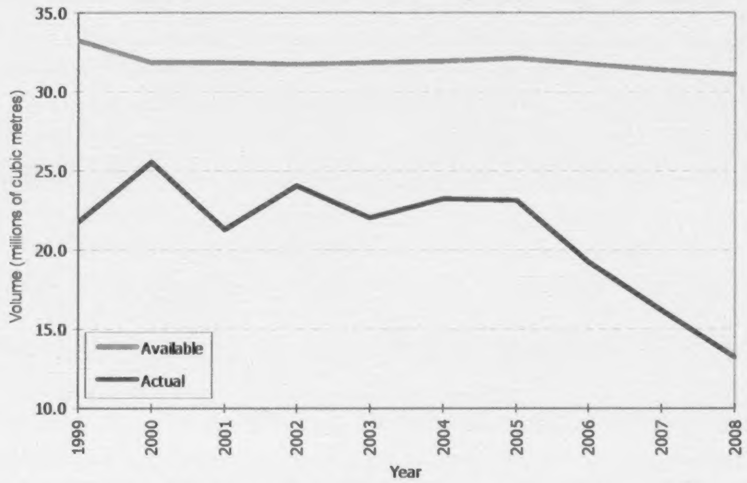


Figure 4: Available versus actual volume of wood harvested from Ontario's managed forest from 1999 to 2008.

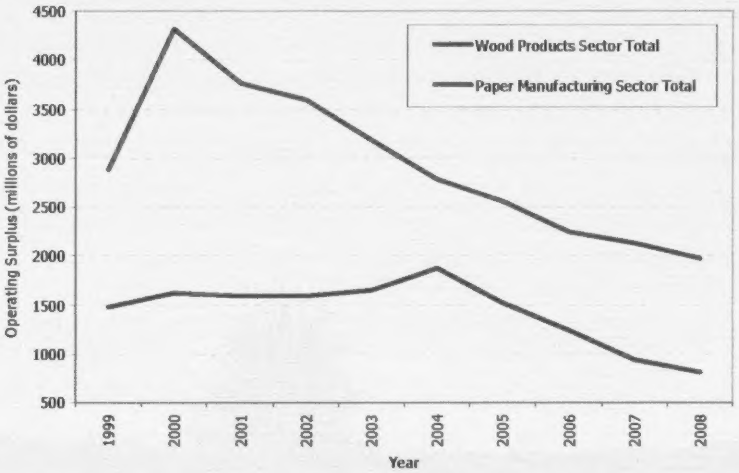


Figure 5: Changes in Ontario paper and wood product manufacturing sector operating surpluses from 1999 to 2008.

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Despite the overall drop in the total value of the operating surplus, the operating surplus margins (a measure of the rate of return) did not decline as significantly. The wood product sector's operating surplus margin declined slightly from 2004 to 2007 before increasing in 2008 (Figure 6). The paper manufacturing sector's operating surplus margin increased slightly from 2004 through 2008. When considered together, the operating surplus margin in the forest sector was more or less unchanged. When faced with poor market conditions, the high cost mills are generally the first to close, therefore the operating surplus margin is reflective of the lower cost and more profitable enterprises.

Forest Sector Investment Levels

Trends in investment provide an indication of a sector's relative business environment. Companies generally choose to pursue investment opportunities when the market indicates strong future demand and a favourable price-to-cost relationship. Alternatively, when conditions are unfavourable investment opportunities are perceived to be risky, with uncertain return on investment.

Capital investment is the monetary value of machinery, plants, buildings, and equipment that is purchased by companies for production purposes. From 2004 to 2008, the average annual investment in capital and repair expenditures in Ontario's forest industry was $1.0 billion (Indicator 5.2.3). The level of capital investment declined by 29% over this period (Table 1).

In addition to capital investment, companies generally invest in research and technology to improve the efficiency of their operations. Tracking private sector investment in research and technology development is difficult. Headquarters for most forest companies are outside Ontario and their research and development expenditures are not reported by jurisdiction. Additionally, research and development program expenditures are often treated as proprietary information and are not publicly available (Indicator 5.2.4). As an example, however, between 2004 and 2008 contributions from Ontario's forest sector to a national research and development organization declined by 35% (Figure 7).

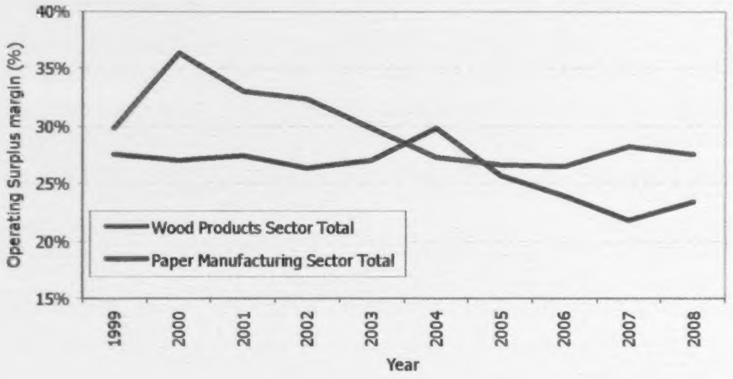

Figure 6: Changes in Ontario paper and wood product manufacturing sector operating surplus margins from 1999 to 2008.

Year	Ontario Industry Expenditures		
	Capital expenditures	Repair expenditures	Total investment (capital and repair)
2004	$558.00	$642.60	$1,200.60
2005	$544.10	$616.30	$1,160.40
2006	$483.50	$552.50	$1,036.00
2007	$452.70	$494.40	$947.20
2008	$423.90	$433.30	$857.20

Table 1: Ontario's forest sector capital investment and repair expenditures between 2004 and 2008 (in millions of dollars).

Forest Sector

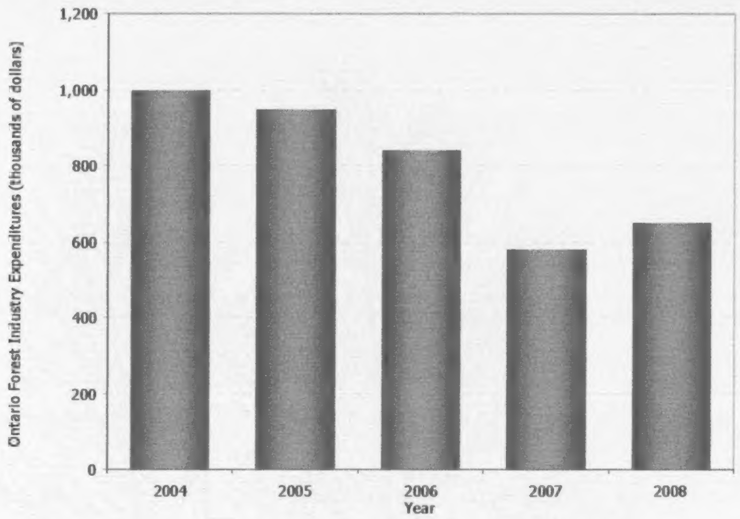

Figure 7: Ontario forest industry investment in Forintek's research and development program from 2000 to 2008 (Source: FPInnovations).

Forest Sector Revitalization

The Canadian Council of Forest Ministers (CCFM) was established in 1985 to provide the federal, provincial, and territorial governments with an opportunity to work together to address forestry related matters. In their long-term strategic vision for sustainable forest management in Canada (*A Vision for Canada's Forests: 2008 and Beyond*), the CCFM identified forest sector transformation as a priority of national importance to maintain a prosperous forest sector. While diversification into new areas is important to maintain a strong forest sector, primary manufacturing will continue to play a major role within the sector.

The CCFM identified several opportunities for forest sector transformation, including:

- The development of a bioeconomy
- Increasing the production of value-added wood products
- Increasing the production of non-timber forest products

Ontario's progress related to these CCFM opportunities are examined in this forest sector theme, and other initiatives underway to revitalize the forest sector are outlined.

Development of a Bioeconomy

The term bioeconomy describes an economy based on the manufacturing and trade of goods and services made from renewable resources. While the bioeconomy includes traditional wood products, the emerging bioeconomy uses resources from Ontario's forests to develop new bioproducts (e.g., bioplastics, and biofuels, and biomass–generated energy). The developing bioeconomy is expected to increase the benefits derived from Ontario's forests, help diversify the forest sector, and make it more resilient to economic downturns.

A promising aspect of Ontario's bioeconomy is the use of forest biomass to generate energy. Ontario's pulp and paper sector has increased the use of forest biomass for energy. In 2007, 54% of the energy used by Ontario's pulp and paper sector was derived from forest biomass (Indicator 4.2.1). Ontario Power Generation is also implementing the use of forest biomass to generate electricity in some of its coal-fired generating stations.

Forest Sector

Value-Added Wood Products

Value-added wood products are items with additional processing beyond the commodity level. The manufacture of value-added products can generate additional jobs and income from the same resource base used to produce primary products. An example of a value-added product is a cabinet, where additional processing of primary commodities (e.g., lumber, plywood, and veneer) is undertaken to create a product with greater value than the sum of the primary products.

Compared to other Canadian jurisdictions and neighbouring jurisdictions in the United States, Ontario is a leader in value-added wood production. Value-added wood processing grew through the 1990s and early 2000s as shown in Figures 8 and 9. From 2004 to 2008, Ontario's value-added wood products sector declined significantly (Indicator 5.3.2). Employment in Ontario's value-added wood processing sector decreased 22%, with 59,224 people employed in 2004 compared to 46,367 in 2008 (Figure 8). The total value of shipments declined 25%, from $12.2 billion in 2004 to $9.1 billion in 2008 (Figure 9). The decrease in both employment levels and the value of shipments illustrates that the value-added wood processing sector was not immune to the downturn in the forest sector.

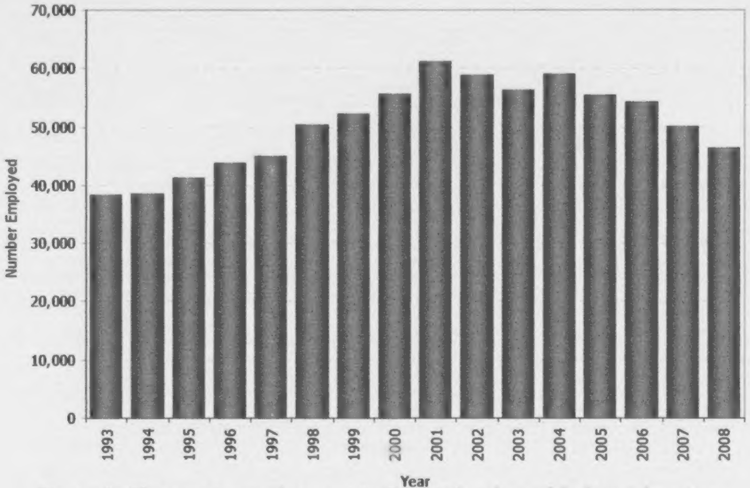

Figure 8: Changes in employment in Ontario's value-added wood sector between 1993 and 2008.

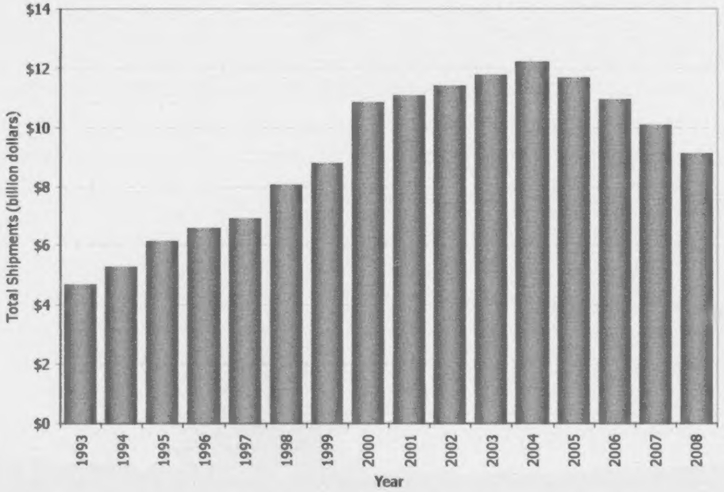

Figure 9: Total shipments in Ontario's value-added wood sector between 1993 and 2008.

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Non-Timber Forest Products

Non-timber forest products (NTFP) range from locally gathered and marketed products (e.g., blueberries and mushrooms) to higher-value niche products harvested for local and international markets (e.g., maple syrup products). Non-timber forest products add value to Ontario's forests, generating additional jobs and income beyond the traditional forest sector.

Examples of harvested NTFP include:

- Medicinal plants (e.g., Canada yew)
- Wild foods (e.g., maple syrup, mushrooms, and blueberries)
- Floral greens (e.g., ferns and boughs)
- Fragrances (e.g., balsam fir)
- Fibres (e.g., cedar bark and spruce roots)
- Plant dyes
- Garden plants
- Arts and crafts materials

The harvesting of many NTFPs is not monitored in Ontario. Canada yew is used as an indicator of NTFP economic activity. Canada yew harvesting levels fluctuated significantly from approximately 356,000 kilograms in 2004 (2006 SOF) to 14,000 kilograms in 2010 (Indicator 5.3.3). The decline in harvesting levels was due to a decline in the Canada yew biomass market, which tends to be cyclical in nature based on demand.

Canada Yew

Canada yew (also called eastern yew or ground hemlock) is a woody evergreen shrub that grows in the understory of the Great Lakes-St. Lawrence and boreal forests of Ontario. The foliage, bark, and roots of this shrub are an important source of compounds for the pharmaceutical industry. For more information on Canada Yew please refer to the *Canada Yew in Ontario* State of the Resource Report available on Ontario's Forests website.

Forest Sector

Revitalization Initiatives

Between 2004 and 2008, several initiatives were implemented to revitalize the forest sector. Some of the initiatives were designed to diversify the forest sector into new areas while others supported Ontario's existing forest sector. A number of the initiatives were initiated in response to the Minister's Council on Forest Sector Competitiveness. The Council was established by the Minister of Natural Resources in November 2004 to advise the government on ways to strengthen Ontario's forest industry. The Council's final report was released in May 2005 and is available on the MNRs website. Initiatives implemented between 2004 and 2008 included:

- **Forest Sector Prosperity Fund ($150 million) and Loan Guarantee Program ($350 million):** The two initiatives were established to support the forest sector and increase investment in several areas including new value-added manufacturing, increased fibre use efficiencies, improved energy efficiency, and the development of co-generation.

- **Northern Pulp and Paper Electricity Transition Program:** The fund provided $140 million for electricity cost relief to northern pulp and paper mills while mills transitioned to greater electricity efficiency.

- **Centre for Research and Innovation in the Bio-Economy:** A $25 million investment helped establish the Centre for Research and Innovation in the Bio-Economy (CRIBE) to conduct research into new products and processes that use wood fibre as a raw material.

- **Provincial Forest Access Roads Funding Program:** The program was established in 2005 to support the construction and maintenance of primary and secondary forest access roads. By 2008 $178 million was contributed towards the public forest road infrastructure.

- **Ontario Wood Promotion Program:** An investment of $1 million dollars per year was provided to expand markets for the province's wood products and increase production of value-added wood products including funding for the Ontario Wood Product Export Association to develop and promote international awareness of Ontario's wood products industry.

In addition to the initiatives discussed above, the Provincial Wood Supply Competitive Process and the Forest Tenure and Pricing Review were initiated in 2009. The Provincial Wood Supply Competitive Process was launched to attract new investment in the forest sector by allocating previously unutilized Crown wood volumes. The Forest Tenure and Pricing Review is expected to help re-energize Ontario's forest sector by creating new jobs and attracting new investment.

Summary

Ontario's forest sector generates substantial economic benefits for the provincial economy. From 2004 to 2008, the forest sector experienced a major economic downturn. While downturns are not new to the forest sector, this downturn was much more severe and prolonged than previous downturns. The downturn had a negative impact on forest harvesting, employment levels, and forest sector profitability. Several initiatives were implemented to revitalize the forest sector to ensure it continues to play an important role in Ontario.

Biodiversity

Ontario's Biodiversity Strategy (2011) refers to biodiversity as the variety of life on Earth, as expressed through genes, species, and ecosystems. Biodiversity includes the variety of species in a given area as well as the amount of genetic variation found within individual species. The variety and distribution of ecosystems and their associated processes are also important components of biodiversity. Some areas are naturally more diverse than others. The deciduous forest region of southern Ontario for example has a higher level of species diversity than the Hudson Bay Lowlands forest region of northern Ontario.

Biodiversity is essential to our survival, providing a wide array of ecosystem services. While the importance of biodiversity is relatively well known, a number of factors threaten biodiversity. Some of the greatest threats to biodiversity include habitat loss, invasive species, pollution, unsustainable use, and climate change.

The SOF C&I framework includes several biodiversity-related indicators that focus on Ontario's forests. The state of biodiversity in Ontario's Crown forests is assessed by examining the conservation of ecosystem diversity, species diversity, and genetic diversity. For a broader evaluation of the province's biodiversity, refer to the *State of Ontario's Biodiversity 2010* report.

The MNR is the steward for Ontario's Crown forests. Approximately 10% of the forested land in Ontario is privately owned. The ultimate decision of how private land in Ontario is managed is made by the landowner. The MNR encourages private land stewardship, and plays an important role in advising, supporting, and promoting the protection of Ontario's biodiversity on private lands through information and incentives such as:

- Managed Forest Tax Incentive Program
- Conservation Land Tax Incentive Program
- Ontario Stewardship Councils
- Species at Risk Stewardship Fund
- Species at Risk Farm Incentive Program
- Community Fisheries and Wildlife Involvement Program
- Advice to municipalities on the development of tree by-laws under the *Municipal Act* (2001)

These initiatives increase awareness on the importance of maintaining and enhancing forest cover across southern Ontario.

Biodiversity

The Importance of Biodiversity

The importance of biodiversity in Ontario's Crown forests was formalized into Ontario's policy framework in the *Crown Forest Sustainability Act* (1994). Since then, Ontario's forest program has evolved to preserve the province's biodiversity heritage by creating diverse ecosystem conditions that emulate natural patterns and processes. The Government of Ontario's commitment to maintaining and enhancing biodiversity in Ontario's Crown forests is reflected in the following legislative and policy tools:

- Old Growth Policy for Ontario's Crown Forests (2003)
- Endangered Species Act (2007)
- Far North Act (2010)
- Forest Management Guide for Great Lakes-St. Lawrence Landscapes (2010)
- Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales (2010)
- Ontario's Biodiversity Strategy (2011)

Ecosystem Diversity

Ecosystem diversity is a measure of the variety of habitat, ecological communities (including micro-organisms, plants, and animals), interactions, and important ecosystem processes (e.g., production, decomposition, energy, and nutrient cycling). Maintaining ecosystem diversity is necessary because species become vulnerable without sufficient quantity and quality of habitat. Ontario's SOF C&I framework assesses ecosystem diversity by examining the composition and structure of ecosystems, the level of forest fragmentation, and the amount of parks and protected areas.

Composition and Structure of Ecosystems

From 2004 to 2008, the amount of forested area and the composition and structure of the forested area remained relatively stable (Indicator 1.1.1). Approximately 52% of the province is forested and an additional 14% is treed wetland (Figure 2). The total amount of forest cover dropped by 0.2% from 71.2 million hectares in 2004 to 71.1 million hectares in 2008. Most of the change was attributed to better information acquired through improved technology (e.g., higher resolution satellite imagery) rather than actual changes in forest cover.

Small changes were observed in forest type with slight increases in red pine, jack pine, and tamarack. Slight decreases were noted in black spruce, maple, cedar, and oak. Minor changes were also noted in the seral stages (age groupings) with shifts from mature (0.8% decrease) and late successional (0.6% decrease) stages to the pre-sapling (young) forest seral stage (1.7% increase). The changes in seral stage are primarily attributed to improvements in information, however forest succession and disturbances such as fire, forest harvesting, insects and disease, and blowdown also affect the seral stages.

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For more detailed information about Ontario's forests, refer to the *Forest Resources of Ontario 2011* report (available on the Ontario's Forests website.

Forest Fragmentation

The level of forest fragmentation (i.e., how broken up or dispersed forests are on the landscape) affects ecological processes and wildlife. Some species, such as white-tailed deer and moose, thrive in fragmented habitats while other species, such as American marten, require larger patches of well-connected forest. Excessive fragmentation may contribute to the loss of plant and animal species that are unable to adapt to fragmented forest conditions.

Forest fragmentation levels were calculated by ecozone. Ecozones are large areas of land and water characterized by bedrock that differs from the bedrock areas next to it. The bedrock and long-term climate patterns affect the ecosystems that occur within ecozones. Ontario is composed of the Hudson Bay lowlands, the Ontario shield (boreal and Great Lakes-St. Lawrence), and the Mixedwood plains ecozones (Figure 10).

Fragmentation levels in the area of the undertaking (which encompasses portions of the Ontario shield boreal and Ontario shield Great Lakes-St. Lawrence ecozones) were relatively stable (Indicator 1.1.2). Southern Ontario (the mixedwood plains ecozone) showed a trend to fewer, smaller, and more fragmented forests (Figure 11).

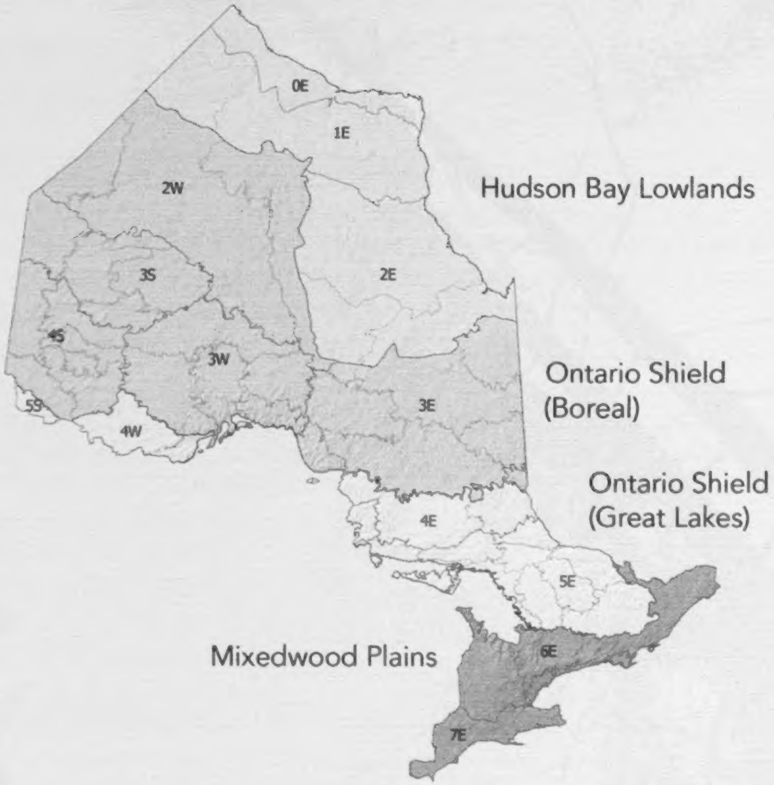

Figure 10: Ontario ecozones.

Anthropogenic corridors (e.g., roads, utilities, and railways) also contribute to forest fragmentation. The effect of the corridors on wildlife and ecosystem diversity varies depending on corridor density, use levels, and location. Generally, as corridor density increases so does the probability that wildlife habitats and populations may be negatively affected.

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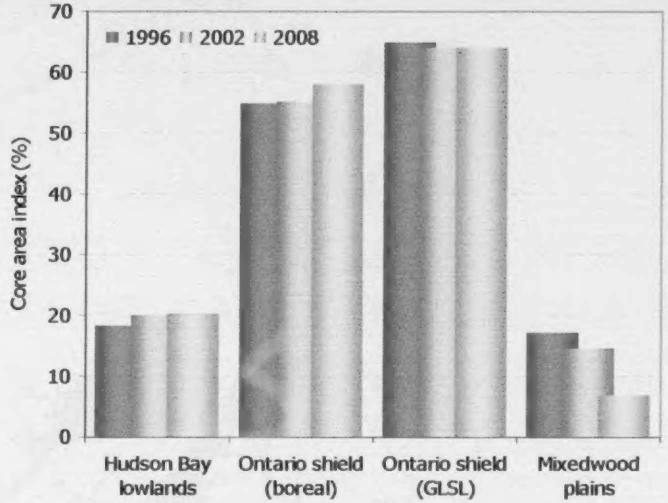

Figure 11: Changes in core area index (a measure of forest interior patches) by ecozone between 1996 and 2008 (GLSL = Great Lakes-St. Lawrence).

From 2004 to 2008, the annual increase in forest access road corridor area remained relatively consistent and was similar to increases observed during the 1999 to 2003 reporting period. From 2004 to 2008, the amount of area in forest access road corridors increased by approximately 69,000 hectares (13,900 hectares annually) from 2004 to 2008 (Table 2). In 2008, forest roads occupied approximately 2% of Crown land within the area of the undertaking. No detectable increases were observed in the utility or railway corridor area (Indicator 1.1.4). From 2004 to 2008, 22,006 km of new roads were constructed. During the same time period, 2,833 km of road were decommissioned and an additional 7,783 km of roads had some form of access control in effect.

Year	New Roads (hectares)	Total Roads (hectares)
2004	8,488	906,345
2005	13,794	920,139
2006	18,732	938,871
2007	15,383	954,254
2008	12,960	967,214
Average:	13,871	-

Table 2: Total area of roads in the area of the undertaking in hectares from 2004 to 2008.

Parks and Protected Areas

Ontario's system of parks and protected areas support the conservation of biodiversity. Since 2006, over 167,000 hectares were added to parks and protected areas. Ontario's parks and protected areas now total 9.6 million hectares or 9.7% of Ontario's land mass (Indicator 1.1.3).

The importance of maintaining ecological integrity in Ontario's parks and protected areas is outlined in the *Provincial Parks and Conservation Reserves Act* (2006). The exclusion of forestry operations combined with active forest fire suppression has contributed to an artificial forest condition (older forests with later successional forest species) within some of Ontario's parks and protected areas. The MNR's *Fire Management Policy for Provincial Parks and Conservation Reserves* (2002) recognizes the importance of fire management planning in provincial parks and conservation reserves as a tool to restore and maintain ecological integrity.

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The policy is expected to help increase natural disturbance within parks and help to maintain more natural ecosystems. Since 2005, eight fire response plans and one fire management plan were established. Active fire management is occurring in several large parks and conservation reserves.

In addition to Ontario's regulated parks and protected areas, some conservation areas are owned and managed by organizations and private landowners and contribute to the conservation of biodiversity. These non-Crown conservation areas are estimated to cover in excess of 1.5 million hectares. While their precise contribution is difficult to determine – identifying the land use of private forests is voluntary – these conservation areas are thought to contribute significantly to the conservation of biodiversity for forest associated species particularly in southern Ontario where regulated protected areas are less common.

Species Diversity

Species diversity refers to the number of species present in a given area. Changes in species populations may provide an early warning of changes in ecosystem integrity or the beginning of long-term changes in population size or distribution. Ontario's SOF C&I framework assesses species diversity by examining wildlife population levels, the number of species of conservation concern, and the abundance of invasive species.

Wildlife Population Levels

Forest management activities are conducted with the objective of maintaining forest conditions similar to those expected to occur within natural disturbance-driven ecosystems. The objective is achieved through the application of coarse and fine filters. Coarse filters emulate natural disturbances at the landscape level to provide a diversity of ecosystem conditions, in turn providing forest habitat for most species. Fine filters are then applied to provide specific habitat requirements for individual species (e.g., maintaining residual forests adjacent to nests or moose aquatic feeding areas) that are not necessarily met using coarse filters.

Not all wildlife species can be effectively and efficiently monitored. Some species are difficult to detect, and attempting to monitor all species would be cost-prohibitive. The MNR's Ontario Terrestrial Assessment Program monitors a variety of species to represent a variety of habitat requirements.

Ontario has implemented monitoring programs for several groups of wildlife species, including:

- Moose
- Caribou
- White-tailed deer
- American marten
- Pileated woodpecker
- Forest birds
- Salamanders
- Small mammals

Monitoring these species will provide long-term assessment information that supports forest management guide effectiveness monitoring. Populations of most of the provincially featured species (white-tailed deer, moose, and pileated woodpecker) have been stable or increasing since 2000 (Indicator 1.2.2).

American marten population levels varied across its range; it was relatively stable in some areas, decreased in others, and fluctuated through time. Migratory forest bird surveys indicated long-term declining trends in some species. It is unclear what is causing the declines, they may by due to fluctuating populations of spruce

Biodiversity

budworm and other food sources, climatic variation, or unknown influences on wintering range or migratory routes. Short-term trends in monitored resident bird species (non-migratory) did not change noticeably. Small mammal populations exhibited high year-to-year variation that was primarily related to changes in food supply.

Wildlife species experience natural population fluctuations over time. Long-term data are required to differentiate natural fluctuations from true population changes. Data for some species were limited. To address the need for additional data, the MNR is testing a comprehensive multi-species monitoring program with the intent of providing data on many species and their habitats over large areas and long timeframes.

Species of Conservation Concern

Species of conservation concern are typically those that are rare or whose populations are declining. Species of conservation concern are identified and tracked by the MNR's Natural Heritage Information Centre (NHIC).

In 2010, 855 forest-associated species were identified as being of conservation concern in the NHIC's database (Indicator 1.2.1). In general, the NHIC does not track species that are widespread and abundant; therefore, most of the species listed in the NHIC database are of conservation concern. More than 30,000 species are estimated to occur in Ontario.

Since 2005, the conservation status of 819 species stayed the same, 14 species had their conservation status up-listed (declining conservation trend), 13 species had their conservation status down-listed (improving conservation trend), 67 species were removed from the list (improving conservation trend), and nine new species were added to the list (Figure 12). The number of critically imperilled species (species that are extremely rare and have a very high risk of disappearing from Ontario) decreased between 2005 and 2010. In most cases species were down-listed due to improved knowledge of their distribution and abundance, not because their populations expanded.

Ontario's *Endangered Species Act* (2007) was created to identify species at risk, protect their habitat, and promote the recovery of species at risk. Species at risk are identified by the Committee on the Status of Species at Risk in Ontario (COSSARO). The NHIC's information on species of conservation concern is one source of information available to COSSARO for their assessment of species at risk. Habitat regulations and relevant policies for forest-related species at risk are incorporated into applicable forest management plans.

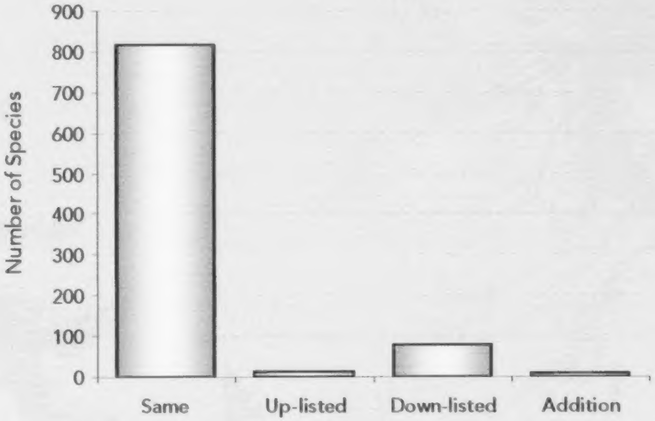

Figure 12: Conservation status rank changes of forest-associated species of conservation concern (2005 to 2010).

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Species conservation is of most concern in southern Ontario where habitat loss is highest. Human pressure and the associated agricultural, industrial, and urban development have substantially reduced the amount of forest habitat. Most of the newly added species of conservation concern occur in southern Ontario. Enhancing the forested area in southern Ontario would help provide habitat for forest-associated species of conservation concern.

Invasive Species

Invasive species are a threat to biodiversity in Ontario's forests. In the absence of natural predation and competition which limits their distribution and abundance in their natural habitats, introduced species may become invasive. Invasive species typically reproduce rapidly, damaging or destroying native species or their habitat. Increases in world travel and transoceanic commerce have increased the spread of invasive species. Anthropogenic corridors (e.g., roads and railways) play a major role in the movement of invasive species.

The known number of introduced forest-associated plant species declined from 1,087 species in 2006 to 1,033 species in 2008 (Indicator 1.2.3). The decline in the number of introduced plant species is largely attributed to better accounting of species rather than an actual decrease in introduced species. A number of introduced plant species (e.g., garlic mustard and Norway maple) have become invasive in Ontario's forests. Some of these species are highly invasive (e.g., kudzu and dog-strangling vine).

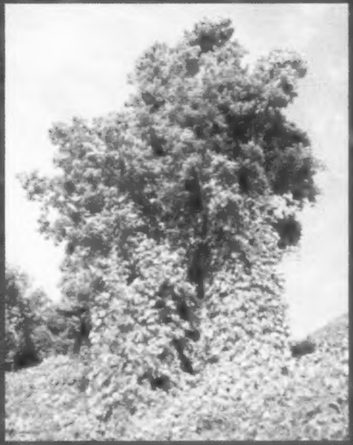
Kudzu Vine

Kudzu vine is a climbing vine that is a member of the pea family (Fabaceae). The vine is woody in appearance and can grow up to 10 centimetres thick and may weigh up to 45 kilograms.

Kudzu is native to eastern Asia and was first brought to the United States in 1876. The vine was later promoted as a forage crop and planted widely along highways for erosion control. Kudzu was first reported in Canada in 2009 when it was found near Leamington in southwestern Ontario.

Kudzu is an aggressive invader, spreading mostly through its root system and runners. Up to 30 vines can grow from a single root system.

Kudzu grows at an astonishing rate of up to 30 centimetres per day and can grow up to 30 metres in a single season. The vine will blanket almost anything, including trees, hydro poles, and houses. It kills existing trees species in the invaded area either by choking them as it climbs, breaking them from the weight of the vines, or by blanketing them and causing death by preventing sunlight from reaching the leaves.



Kudzu vine (Photo courtesy of Eric Cleland, MNR).

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In addition to invasive plant species, several insects and diseases continued to be significant damaging agents in Ontario's forests. Examples of invasive insect species included: emerald ash borer, European woodwasp, and Asian long-horned beetle. Invasive diseases of concern included butternut canker (Indicator 2.2.3).

The survey and control of invasive forest species is generally led by the Canadian Food Inspection Agency. The MNR works closely with the Canadian Food Inspection Agency and the Canadian Forest Service on all aspects of invasive species. The MNR delivers the Ontario Forest Health Monitoring Program, which includes the monitoring and management of invasive species in Ontario. For more information about invasive insects and diseases, refer to the forest health condition annual reports available on the MNR's website.

Ontario and Canada partnered to establish the Invasive Species Centre (ISC) in Sault Ste Marie. The ISC is a not-for-profit corporation governed by a diverse board of directors and is housed in a recently refurbished wing of the Great Lakes Forestry Centre. The mandate of the ISC is to improve coordination and decision making in invasive species prevention, management, and research. The ISC will also support the strategic goals and challenges outlined in the national and provincial invasive species strategies.

Recently the MNR created the Biodiversity Explorer website, an online information source for over 15,000 plants and animals and over 450 ecological communities in Ontario. As well, the MNR has partnered with the Ontario Federation of Anglers and Hunters (OFAH) to fund the Invasive Species Awareness Program to help prevent the spread of invasive species. Through the partnership, the OFAH operates an Invading Species Hotline. Members of the public are asked to report sightings of invasive species to the Invading Species Hotline online or at 1-800-563-7711.

The Ontario Invasive Plant Council is a non-profit multi-agency organization that was founded in 2007 to raise awareness of invasive plant issues across the province. For more information, visit the Ontario Invasive Plant Council website.

Asian long-horned beetle

Biodiversity

Genetic Diversity

Genetic diversity refers to variation at the level of individual genes within a particular species. Genetic diversity provides a mechanism for a population to adapt to a changing environment. Generally, the greater the level of gene variation, the greater the likelihood that some individuals in a population will possess genetics suited to the new environment. Generally, populations are genetically adapted to local conditions.

The conservation of genetic diversity is considered within the provincial forest management planning system. Ontario currently has 38 first-generation seed orchards under active management. The seed orchards are established using seed from trees with desirable characteristics (e.g., faster growth rates). The seed orchards in turn provide genetically improved seed for forest renewal to enhance forest productivity. An assessment of Ontario's seed orchard program indicates a sufficient level of genetic diversity was maintained to enable newly regenerated forests to be resilient to changing environments (Indicator 1.3.1).

Successful artificial renewal relies on a sustainable supply of high quality seed. Although the seed collection program declined compared to previous reporting years, an adequate supply of seed was being collected to support Ontario's forest renewal needs (Indicator 1.3.2).

Summary

Most indicators related to forest biodiversity remained relatively stable from 2004 to 2008. The amount of forested area, species composition, and forest fragmentation levels remained relatively stable in the area of the undertaking and they have been stable for decades. Southern Ontario had fewer, smaller, and more fragmented forests and increased numbers of species of conservation concern. Invasive species continued to pose a threat to biodiversity.

While the indicators related to forest biodiversity were relatively stable, climate change is expected to affect biodiversity in Ontario's forests. For additional information, refer to the climate change theme in this report. Ontario's large and growing human population will also continue to place pressures on forested habitats in southern Ontario.

Forest Health

The MNR is responsible for ensuring the sustainability, or long-term health, of Ontario's Crown forests. The *Crown Forest Sustainability Act* guides these efforts, defining long-term forest health as maintaining "the ecosystem's complexity while providing for the needs of the people of Ontario."

Ontario's *Policy Framework for Sustainable Forests* identifies that "large, healthy, diverse and productive forests are essential to the environmental, economic, social and cultural well-being of Ontario, both now and in the future." Healthy forests are well-adapted to their growing conditions, are resilient to natural disturbance agents (e.g., fire, insect infestation, disease, and weather events), and are capable of producing an appropriate array of ecosystem services (e.g., raw materials, flood prevention, climate regulation, and soil formation).

Ensuring the Health of Ontario's Crown Forests

Forest management activities in Ontario's Crown forests are permitted through an approved forest management plan. Through MNR's forest management planning process, forest managers ensure that provincial Crown forests will remain healthy to provide sustainable benefits such as timber and commercial products, ecosystem services, wildlife habitat, and recreation opportunities.

Ontario's forest management practices are governed by guides. The guides outline practices and methods to provide for the long-term health of forest ecosystems and to protect values within the forest. Silvicultural practices (the art and science of renewing the forest) consider not only timber production, but also ecological concerns such as biodiversity, wildlife habitat, and water quality. The implementation of these practices through forest management is one way of influencing forest health in the managed Crown forest. Other management actions, including pest control and forest fire management, also contribute to healthy forests.

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How Healthy are Ontario's Crown Forests?

Much of the SOF C&I framework contributes to an overall assessment of forest health. Forest management activities, such as harvest and renewal, along with other factors including fire and severe weather, forest insects, diseases, and invasive species all are important influences on the resilience of the forest ecosystem.

Forest Harvest and Renewal

Boreal forests have, over thousands of years, adapted to large-scale natural events such as forest fires, pest infestations, and wind storms – disturbances that affect entire stands of trees. Several boreal tree species require natural disturbance to regenerate and grow. As a component of ensuring long-term healthy forests, harvesting and forest renewal activities are designed to emulate natural disturbance patterns. The MNR manages forest fires to protect people and their property and to ensure natural resources can be used to generate social, economic, and environmental benefits.

From 2004 to 2008, the annual average harvest area was 180,447 hectares. As discussed in the forest sector theme of this SOF report, harvest levels were directly influenced by the depressed state of the forest industry (Figure 13). Harvest levels were well below sustainable levels as determined in forest management plans. Reduced harvest levels and the associated reduction in forest renewal activities, combined with the suppression of natural disturbances (e.g., fire and insects), could impact the achievement of forest health objectives over the long-term, including wildlife habitat, biodiversity, and socioeconomic objectives.

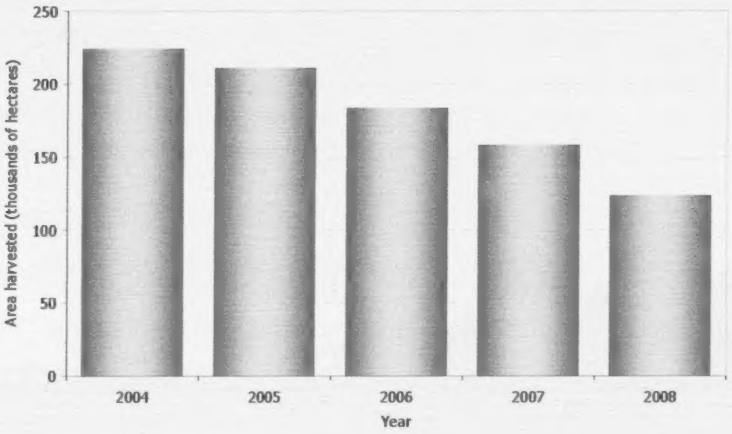

Figure 13: Annual forest harvest area between 2004 and 2008.

The shortfall in forest harvesting levels over time could result in a shift to artificially old forests. This favours species that rely on older forests at the expense of those that rely on younger forests. The amount of old forest was extensive in 2011 with 16% of the total forested area in the area of the undertaking in old growth conditions. The old growth forest was well distributed across the province.

From 2004 to 2008, the average annual area regenerated was 202,947 hectares – approximately 13% higher than the average annual harvest (Indicator 2.3.1). Forest renewal efforts were therefore keeping pace with harvesting. Longer-term analysis back to 1990 also illustrates that renewal efforts closely followed harvest levels (Figure 14).

A renewal delay following harvest can be expected because it typically takes from two to three years to complete assisted renewal treatments (e.g., site preparation, planting, or seeding).

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This renewal delay accounts for the difference between the harvest and renewal levels illustrated in Figure 14.

Another component of developing resilient forests is the success of renewal activities. From 2004 to 2008, an average of 228,421 hectares were assessed annually to determine the success of the renewal treatments. Ninety-one percent of the areas assessed were determined to have been regenerated. The regenerated areas did not always achieve the desired forest type. The MNR is considering options to improve regeneration results by strengthening the silviculture framework. Important components of this action include developing boreal regeneration standards, improving direction for silviculture effectiveness monitoring, and providing leadership for the design and implementation of the funding model for provincial renewal programs.

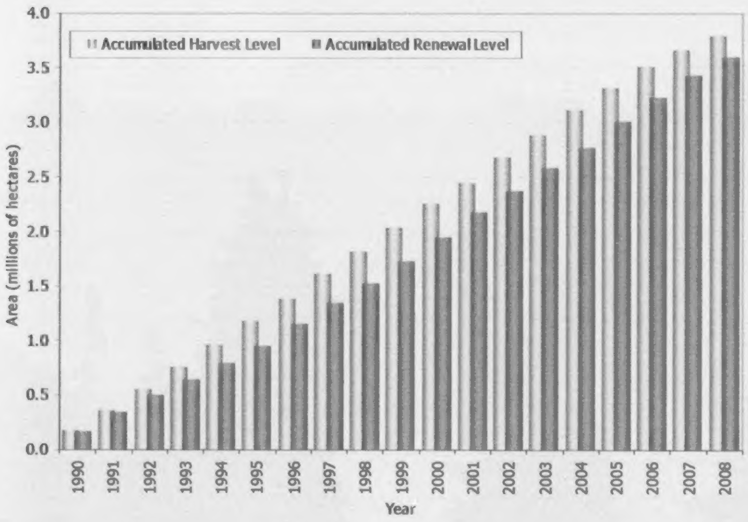

Figure 14: Comparison of area harvested and renewed from 1990 to 2008.

A number of potential risks to the future resilience of Ontario's forests were identified including greater reliance on natural forest renewal, fire and severe weather, forest insects, disease and invasive species, and climate change.

Greater Reliance on Natural Renewal Efforts

Renewal of harvested areas occurs through assisted (e.g., site preparation, planting, and seeding) and natural (e.g., root suckering or seeding) regeneration. From 2004 to 2008, average renewal levels exceeded average harvest levels. During this period, reliance on natural renewal increased, resulting in a corresponding decrease in the amount of some assisted renewal activities such as site preparation and tending (Indicator 2.3.1).

In many instances, natural renewal produces a healthy future forest. On some sites, reliance on natural renewal may not be appropriate because the forest may not establish itself as quickly and other vegetation types may occupy the site.

The trend towards increased reliance on natural renewal resulted from:

- Reducing costs because natural renewal is a less expensive alternative
- Harvesting in site types that are more conducive to natural renewal
- Adjusting harvest techniques to protect young trees that are already growing on site (i.e., protecting advanced renewal)
- Increasing rigour in reporting requirements

Forest Health

Fire and Severe Weather

Ontario's forests are adapted to natural disturbances resulting from fires, severe weather, insects, and diseases. Forest fires in particular are an important part of the cycle of forest renewal. Due to the potential negative impact forest fires can have on human life and property, fires have been aggressively suppressed in the province for decades. Forest fire suppression has resulted in a forest that, in some places, is different from the forest that would be there without human intervention. Today, many of our forests are older with more dead and dying trees than would be there under natural conditions. Too little fire in some areas can decrease forest health and lead to increased incidences of insect infestation, disease, severe weather effects, and catastrophic fire events. Forest fire protection activities are needed when fires threaten property, financial investments, or human life. These activities need to be balanced to allow fire to remove old forest cover, dense underbrush, and debris. These factors are increasingly being considered for fire management purposes.

Ontario's forest fire management strategy outlines how fire response and fire use are practiced together with land use objectives to ensure healthy forests.

From 2004 to 2008, approximately 125,000 hectares of forest were burned by wildfires (Figure 15). During the same period, weather disturbances (ice, wind, frost, and hail) caused tree mortality in approximately 866,000 hectares of forest (Figure 16). The annual average area burned declined over the last 10 years while weather disturbance levels were highly variable (Indicator 2.2.1).

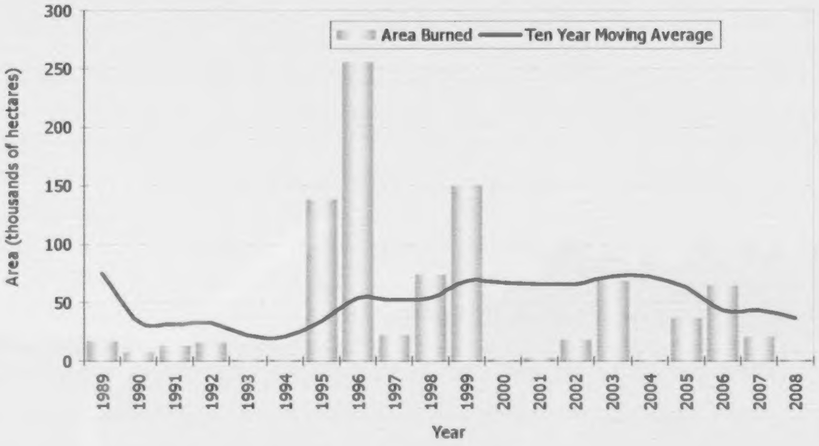

Figure 15: Forest area burned annually from 1989 to 2008.

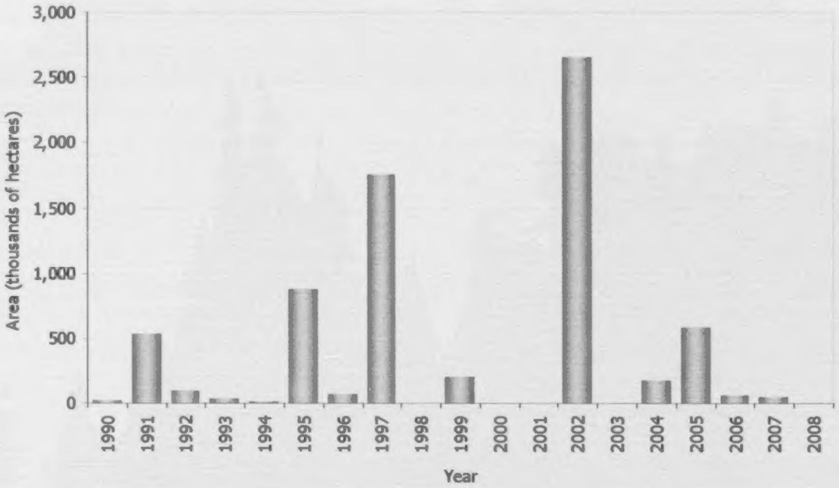

Figure 16: Forest area affected by weather disturbances causing tree mortality from 1990 to 2008.

Forest Health

Monitoring Forest Health

Forest health has been monitored in Ontario since the 1930s in partnership with the federal government. Ontario monitors forest health using a systematic program that combines ground and aerial surveillance.

Monitoring program results are used to report on the health of Ontario's forests and the major factors affecting forest health. The annual *Forest Health Conditions in Ontario* reports are available on the MNR's website. The reports include information about major forest disturbances, invasive species, and regional-level reporting on forest health issues. Monitoring information is used to plan forest management and pest management programs, design research projects, develop invasive species management strategies and climate change programs, and support assessments of forest sustainability and biodiversity.

Forest Insects, Disease, and Invasive Species

Ontario's forests are vulnerable to a range of native (e.g., jack pine budworm) and non-native (e.g., emerald ash borer) insects, diseases, and other pests. The MNR limits the impact of these forest pests through a variety of mechanisms such as:

- Establishing control programs
- Conducting research
- Implementing education and awareness programs for forest managers and the public
- Developing control methods and products
- Developing and implementing policy
- Collaborating with federal and municipal governments, universities, private companies, and other agencies
- Developing best practices

The forest management planning process addresses forest health problems, such as insect and disease outbreaks, as they arise. Forest managers examine a variety of options to address the problems including letting the event run its course, undertaking a control program, conducting a harvest operation in the affected area, or applying some combination of these options.

Levels of insect and disease outbreaks remained relatively low. From 2004 to 2008, insects caused tree mortality in approximately 3.4 million hectares (Indicator 2.2.2). Spruce budworm and jack pine budworm were responsible for 88% of the area affected.

Forest Health

Ontario's forests are under increasing threat from invasive species. The MNR works with other agencies to identify and control or eradicate exotic pests. The MNR is involved in several initiatives to prevent and detect new invaders, and to respond and manage invasive species including:

- Developing an Invasive Species Strategic Plan
- Partnering in an Invasive Species Centre in Sault Ste. Marie
- Providing the public with more information about invasive species

For more information about invasive species and what is being done to control their spread, see the biodiversity theme of this SOF.

Climate Change

Ontario's forests, like other forests around the globe, are susceptible to climate change. Climate change effects may include reduced growth rates, increased mortality, or changes in ecosystem distribution. Climate change can also influence the frequency of forest fires and severe weather events such as storms, floods, droughts, and heat waves, all of which can have serious consequences for forest health. For additional information, refer to the climate change theme of this SOF.

Summary

An assessment of the balance between the forest harvest and renewal levels demonstrated that Ontario's forests were being renewed and were contributing to the resilience of forest ecosystems. The assessment revealed a greater reliance on natural renewal following harvesting activities. Fire, severe weather, insects, and diseases continued to create disturbances in Ontario's forests. Ontario's forests were under increasing threat from invasive species. Invasive species and climate change are expected to have major implications on the health of Ontario's forests in the future.

Climate Change

The Earth's atmosphere is composed of gases, many of which absorb solar heat. The atmosphere's ability to absorb heat is called the greenhouse effect. Greenhouse gases make life on Earth possible by reducing temperature extremes. Rapid growth in industrialization and other activities (e.g., conversion of forests to agriculture and urban land) have increased the amount of carbon dioxide and other greenhouse gases in the atmosphere. As the level of greenhouse gases increase, more heat is trapped raising the Earth's average temperature.

Ontario's climate is changing and becoming increasingly variable. Average temperatures across Ontario have increased by up to 1.4°C since 1948. Changes to temperature, precipitation, and wind patterns are expected to continue as more greenhouse gases are released to the atmosphere.

These changes are expected to affect the composition, structure, and function of Ontario's ecosystems. This climate change theme examines the known and expected effects of climate change on Ontario's forests along with opportunities for Ontario's forests to mitigate and adapt to climate change.

The MNR has developed a strategic plan to address climate change. The MNR is responding to climate change by working to:

- Understand the effects of climate change on Ontario's natural resources and ecosystems
- Mitigate climate change by reducing greenhouse gas emissions and by sequestering and storing carbon in ecosystems
- Help Ontarians adapt to climate change

Visit the MNR's website for more details.

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Climate Change

Climate Change Effects

Individual ecosystems occur within a range of specific climatic conditions known as a climatic envelope. A climatic envelope is determined by factors such as the amount of rain, the amount of snow, and temperature. These climatic conditions affect the types of plants and animals that occur in the area. Even a small shift in climate can produce conditions that differ from the climatic envelope for a particular ecosystem, resulting in the ecosystem being unable to thrive or even survive at that location.

The United Nation's Intergovernmental Panel on Climate Change (IPCC) reviews and assesses climate change information. The IPCC projects that the southern limits of climatic envelopes will be pushed northward in the northern hemisphere. Modelling scenarios that assume fossil fuel emissions are not reduced from current levels project that the climatic envelope for the boreal forest (Ontario's largest forest type) may disappear from Ontario by the end of the century and be replaced with a different, probably warmer, climatic envelope.

Species Migration

Climate-driven change is not new to Ontario's forests. During the last ice age, continental ice sheets ebbed and flowed across the provincial landbase. Individual species and the ecosystems they formed were pushed out and migrated as the climate changed. In fact, today's boreal forest formed only a few thousand years ago, long after the last ice age. The difference between ice age climate change and the climate change that is forecast to happen in the coming decades is the speed at which it is expected to occur. Species and ecosystems are unlikely to be able to adapt to the rapid rate at which climate change is forecast to occur. In situations where change exceeds the ability of species to adapt or move, they may be extirpated from (i.e., no longer found in) Ontario.

Results of sophisticated analytical modelling conducted for multiple North American tree species indicates that, during this century, the location of climatic conditions required by species will shift considerably. Eastern white pine is a dramatic example of the expected consequences of climate change (Figure 17). The effects of climate change will differ among species since each will be more or less suited to tolerate the associated stresses. Natural migration is not expected to allow tree species to avoid the effects of climate change.

Assisted migration of tree species involves their artificial relocation through planting or seeding. Assisting the migration of tree species to follow climate envelopes is one option to promote forest adaptation to climate change. Assisted migration is not without its challenges. Although migrated trees may be better suited to the local climate they will be susceptible to the variability in weather events anticipated under climate change. Moving tree species further north may also increase the risk of freezing damage and trees may not be adapted to local day length. The MNR and other resource management agencies are involved in pilot studies to assess the potential for assisted migration as a policy to support forest adaptation in the face of a changing climate.

Climate Change

Bio-Climatic Profile of Eastern White Pine

Likelihood of Occurrence

- ☐ 50-60%
- ☐ 60-70%
- ░ 70-80%
- ▒ 80-90%
- ▓ 90-100%

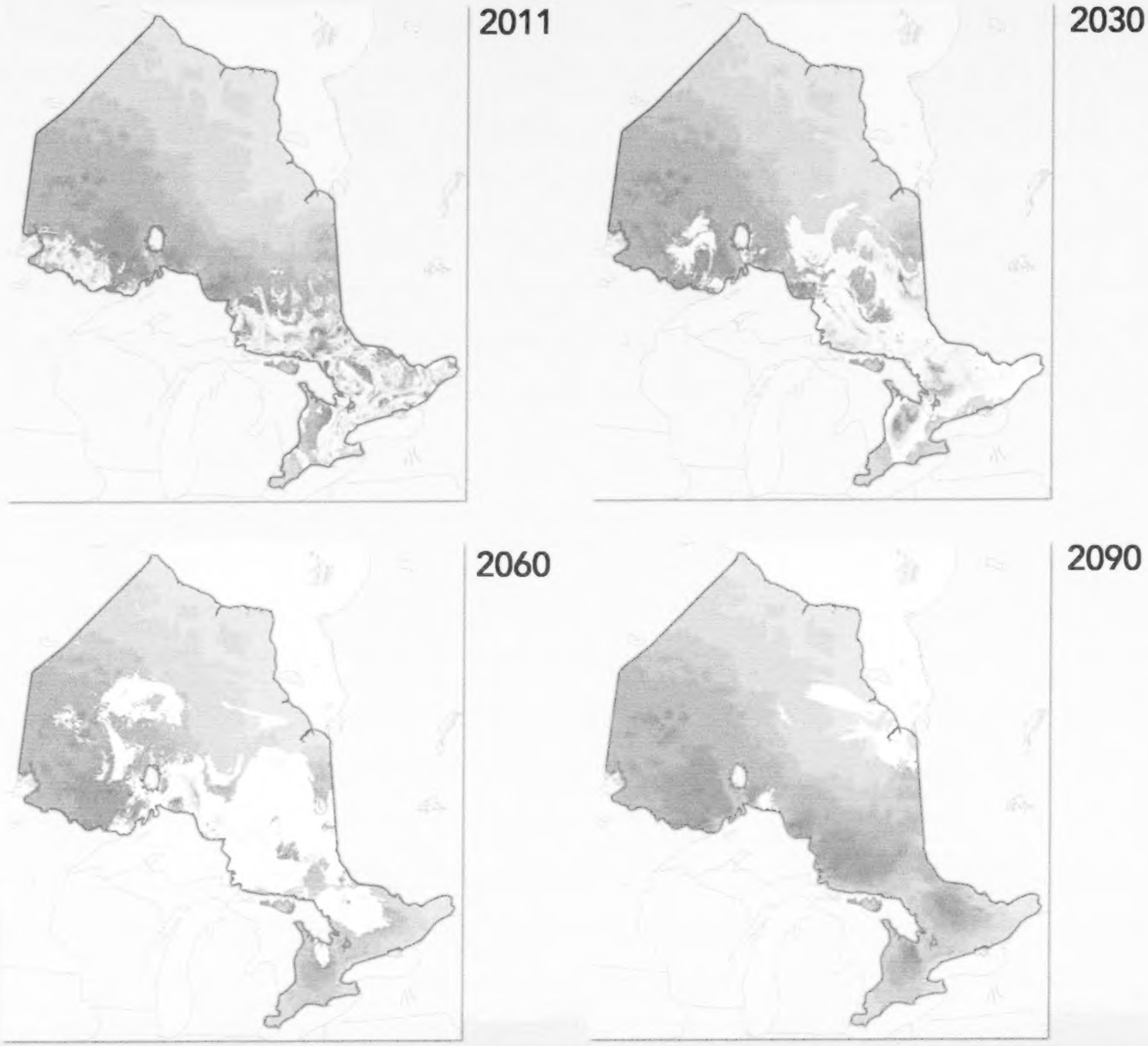

Figure 17: Forecast bio-climatic profile (climatic conditions required by a species) of white pine in Ontario under a changing climate. The 2011 bio-climatic profile represents the climatic conditions under which white pine currently occurs. The three time steps (2030, 2060, and 2090) indicate where the current bio-climatic conditions are projected to occur as the climate changes. Forecasts based on the Geophysical Fluid Dynamics Laboratory Climate Change Model 21 for IPCC climate change scenario A2 (business as usual where global population levels continue to grow and little is done to control greenhouse gas emissions). Maps provided by Dr. Denis Joyce, Ministry of Natural Resources.

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Forest Disturbances

Climate change is expected to increase the number of fires, extreme weather events (e.g., droughts and blowdown), and insect outbreaks. These disturbance levels (discussed in the Forest Health theme of this SOF report) were relatively low from 2004 to 2008 compared to previous periods.

From 2004 to 2008, the number of invasive species and their effect on Ontario's forests continued to increase (Indicators 1.2.3 and 2.2.3). While the increase is not necessarily attributable to climate change, over time a warming climate is expected to facilitate the establishment and survival of a greater number invasive species in Ontario's forests. For more information on invasive species, refer to the Biodiversity and Forest Health themes of this SOF report.

The mountain pine beetle outbreak in western Canada is an example of an insect outbreak that is linked to a warming climate. The mountain pine beetle is native to British Columbia. Historically, cold winters helped control insect survival rates keeping population levels in check. More recently, warmer winters have resulted in increased survival rates allowing populations to reach epidemic levels.

By 2008, the mountain pine beetle outbreak had spread to over 14 million hectares and killed approximately 50% of the mature lodgepole pine in British Columbia. While the infestation peaked in 2007, the outbreak continues to kill large areas of lodgepole pine. By 2015, the outbreak is expected to kill 70% of British Columbia's lodgepole pine. As of 2010, the mountain pine beetle had reached central Alberta and had spread from lodgepole pine to jack pine. If the mountain pine beetle reaches Ontario it could have major implications on Ontario's forests.

Increasing Carbon Storage

Ontario's forests can act as either a source of (i.e., release) or a sink for (i.e., store) atmospheric carbon. Carbon dioxide is removed from the atmosphere by plant photosynthesis (Figure 18). Carbon dioxide is broken down into carbon and oxygen. The oxygen is released back into the atmosphere while the carbon is stored (i.e., sequestered) by plants in leaves, stems, and roots. Forests also contribute carbon to the atmosphere through decomposition when tree mortality occurs.

Trees are particularly good at storing carbon and are almost 50% carbon (by dry weight). At just under four billion hectares, forests occupy 30% of the Earth's land area and store significant amounts of carbon. The total amount of carbon stored in the Earth's forests is estimated to be 638 billion tonnes (includes all forest vegetation, roots, dead wood, and carbon contained in the soil), about the same as the 750 billion tonnes of carbon in the Earth's atmosphere.

Climate Change

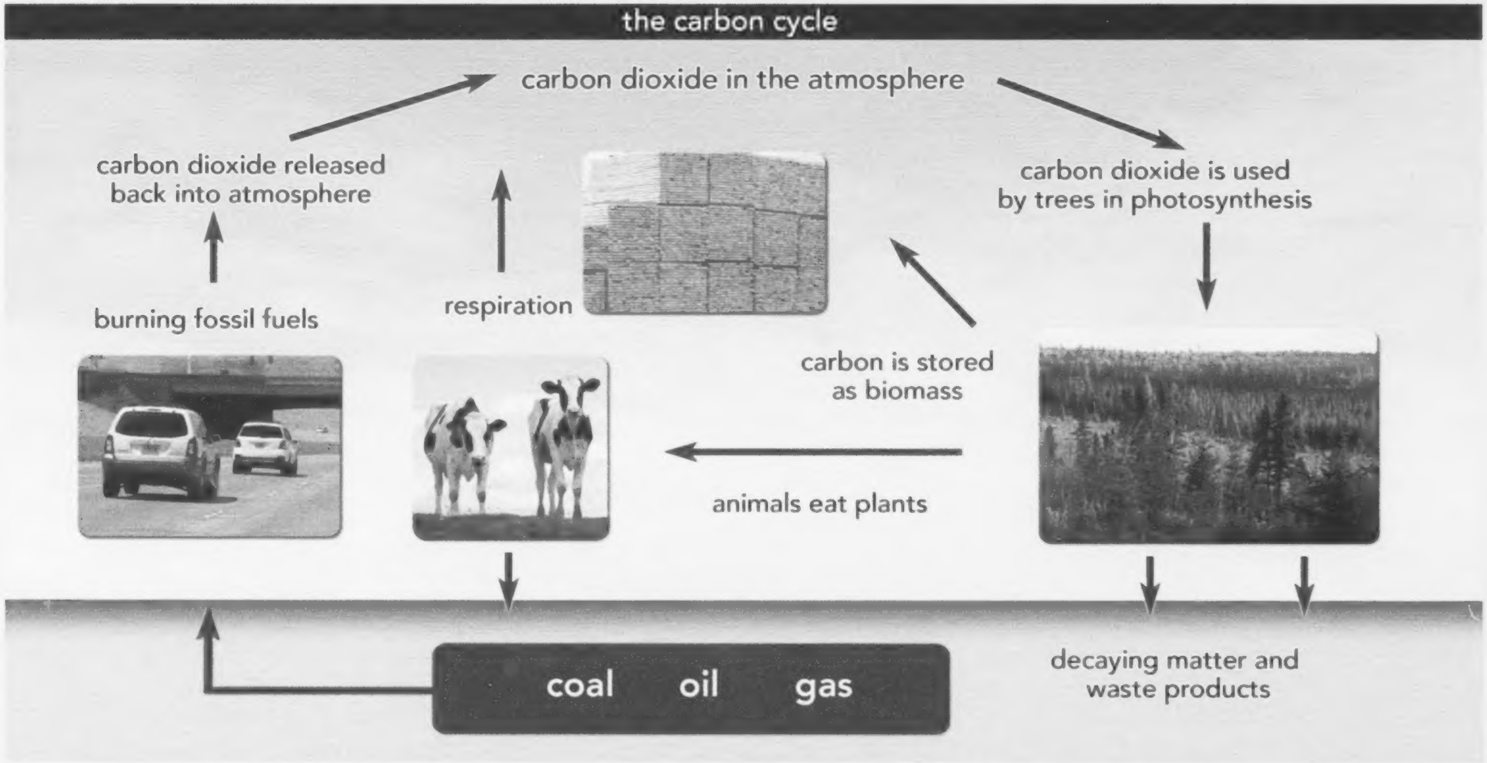
the carbon cycle
carbon dioxide in the atmosphere
carbon dioxide released back into atmosphere
burning fossil fuels
respiration
carbon dioxide is used by trees in photosynthesis
carbon is stored as biomass
animals eat plants
coal
oil
gas
decaying matter and waste products

Figure 18: A simplified illustration of the carbon cycle.

The Carbon Balance of Ontario's Forests

The MNR has assessed the current and forecast levels of carbon in Ontario's forests. Carbon forecasts were based on how planned forest management activities affect forest age, species, and the amount of harvested wood converted into wood products. The work supports policy development and Ontario's involvement in international agreements and negotiations on climate change issues.

In 2010, Ontario's Crown managed forests were estimated to store almost six billion tonnes of carbon (Table 3). The carbon model for Ontario's forests indicates that from 2010 to 2030 Ontario's forests will be a net source of carbon (Figure 19). During that time the forest is still contributing to increased carbon storage by carbon stored in harvested wood products. Starting in 2040, Crown managed forests become a carbon sink until 2100 (Indicator 4.1.1). The potential carbon stored in harvested wood products would be several times greater than that stored in the forest at 2100.

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Value	Crown Land within AOU (not including large parks)	Large Parks	Private Land	Northern Boreal Fire Management Zone	Total Managed Forest
Area (million ha)	28.3	1.7	4.1	5.3	39.4
Carbon stocks (million tonnes)	4,330.2	261.3	667.9	711.5	5,970.9

Table 3: Carbon stocks in Ontario's managed forests in 2010 by land use category

The change from a carbon source to a carbon sink is due to changes in the age structure of the forest. Ontario's forests currently contain many older-aged stands that contain high levels of carbon. As mortality occurs, the stands will release carbon becoming a carbon source. The stands will be replaced by younger forest that contains less carbon. As the young stands age they will begin sequestering more carbon, becoming a carbon sink.

The forest carbon modelling work provides a good foundation for further research and analysis. Future modelling efforts will consider the effects of climate change and various management and harvest scenarios on forest carbon levels.

The MNR is assessing carbon mitigation projects that may have the potential to increase the removal of greenhouse gases from the atmosphere and increase carbon storage in forests and/or harvested wood products. Examples of opportunities for increased sequestration and storage may include:

- Increasing forest cover through afforestation
- Increasing forest protection (e.g., protection from fire, insects, and disease)
- Enhancing stand establishment and tending
- Increasing the use of wood products
- Displacing fossil fuel usage with forest biomass

Further research and analysis is required to determine the mitigation potential of these activities at the landscape and stand level. These activities are discussed in more detail in the following paragraphs.

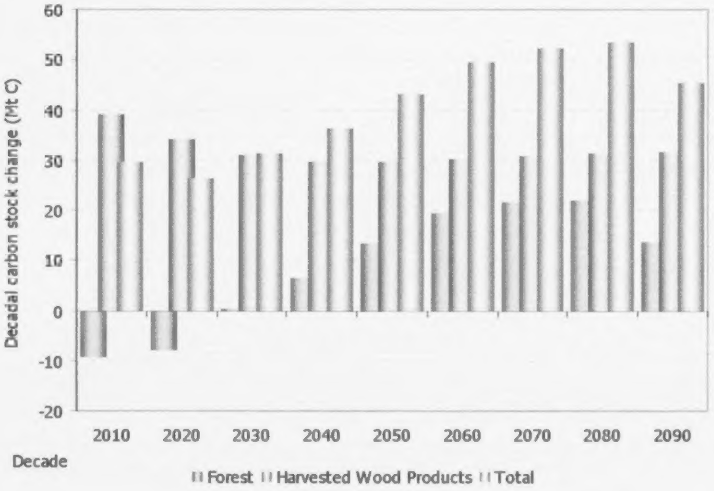


Figure 19: Changes in carbon stocks in Ontario forest management units and harvested wood products (HWP) in million of tonnes of carbon (Mt C) projected over a century. Values above zero represent carbon sinks (i.e., absorb carbon from the atmosphere) while values below zero represent carbon sources (i.e., release carbon to the atmosphere).

Climate Change

Deforestation
Deforestation is the conversion of forested land to non-forest use (e.g., urban or agricultural areas). During deforestation tree stems, roots, and branches are burned, or left to decompose. These actions result in carbon dioxide emissions to the atmosphere. Permanent conversion of forested lands to non-forested land reduces the sequestration of carbon.

Afforestation
Afforestation is the conversion of non-forested areas to forest. The growing trees remove carbon dioxide from the atmosphere and store carbon through photosynthesis (sequestration).

Increasing Forest Cover

Increasing the amount of forest cover by minimizing deforestation and increasing afforestation will increase the amount of carbon sequestered from the atmosphere. Ontario still has a relatively high level of forest cover since agricultural development in the northern portion of the province is limited by short growing seasons and relatively low productivity soils.

Ontario has a long history of successful private land afforestation going back to the 1920s. During the 1980s, up to 30 million trees a year were planted on rural privately owned properties across the province. By the early 2000s, planting levels dropped to as low as 400 thousand trees per year. The drop in planting levels was compounded by the closing of provincial tree nurseries and reduced assistance for afforestation efforts on private land after 1993.

Residential, commercial, and industrial expansion continued to result in the loss of Ontario's forests. In the area of the undertaking, harvested areas are renewed and do not contribute to deforestation. Forest access roads, however, do contribute to deforestation. From 2004 to 2008, approximately 69,357 ha of new forest access roads were constructed (13,871 ha/year) (Indicator 4.1.3). The annual level (13,871 ha/year) corresponds to 0.05% of the total Crown production forest area. Approximately 90% of all roads constructed by the forest industry are short term operational roads. Operational roads may be decommissioned and regenerated after they are no longer required for forest management purposes. From 2004 to 2008, the decommissioning of forest access roads increased and is expected to reduce the area of deforestation in northern Ontario over time (Indicator 7.2.2).

From 2001 to 2007, 8,856 ha of deforestation occurred in southern Ontario (1,265 ha/year) (Indicator 4.1.3). Most of the forest in southern Ontario is privately owned. Deforestation of southern Ontario forests is of concern due to factors such as:

- Their limited extent and fragmented nature
- The relatively large number of forest associated species
- The large number of forest species of conservation concern
- Their role in soil and water conservation and other essential ecosystem services

From 2001 to 2009, 5,422 hectares were afforested in southern Ontario (Indicator 4.1.4) corresponding to an annual average afforestation level of 602 hectares (Figure 20). While the 602 hectares falls short of the 1,265 hectares deforested per year, afforestation levels in southern Ontario have begun to increase as a result of the 50 Million Tree Program (see inset below).

Climate Change

The 50 Million Tree Program is one component of the Ontario government's plan to address climate change. Estimates indicate that this program could remove approximately 6.6 megatonnes of carbon dioxide from the atmosphere by 2050. To put the number into perspective, greenhouse gas emissions in Ontario were 190 megatonnes in 2006.

The environmental benefits of afforestation are offset by current deforestation rates. An analysis of lands available for tree planting in southern Ontario suggested that considerable amounts of private land would likely be made available for afforestation projects if planting costs were paid as an incentive for landowners to participate.

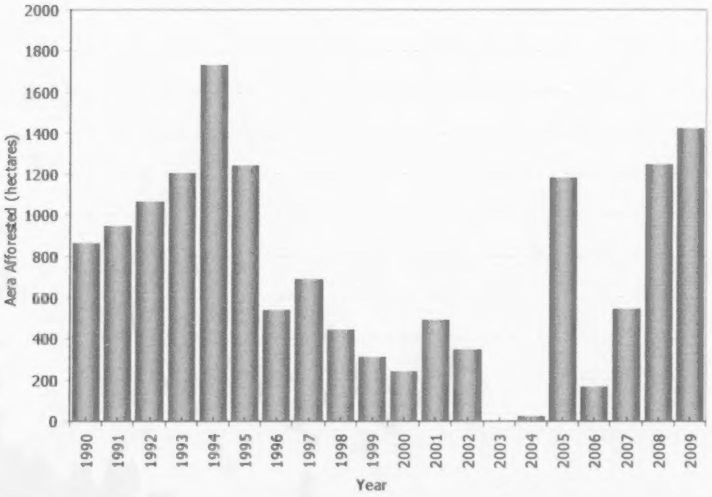
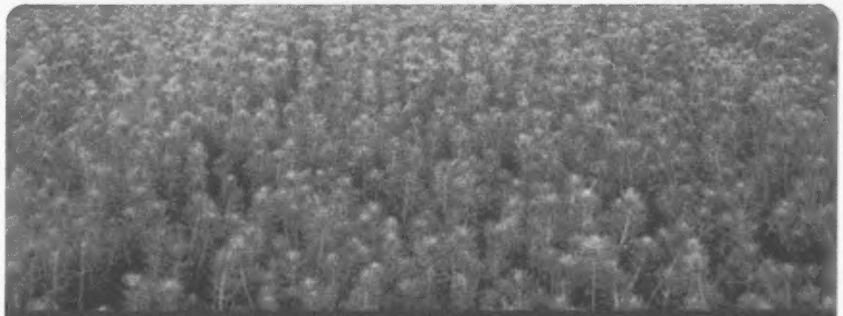


Figure 20: Estimated annual afforestation levels in southern Ontario over the last two decades (2003 data not available).



The MNR has partnered with Trees Ontario to implement the 50 Million Tree Program. The goal of the program is to plant 50 million trees on approximately 25,000 hectares of rural private and public land across southern Ontario by 2020. The trees are being planted to:

- Sequester carbon
- Enhance and diversify southern Ontario's landscape
- Increase wildlife habitat
- Increase soil and water conservation
- Provide local economic opportunities

The 50 Million Tree Program demonstrates Ontario's recognition of a responsibility to manage carbon resources while considering the effects on global atmospheric carbon dioxide levels. Ontario's commitment represents the biggest pledge in North America towards the United Nations Billion Tree Campaign, the goal of which is to plant one billion trees worldwide each year.

By 2010, 5.7 million trees had been planted under the 50 Million Tree Program (an average of 1.9 million trees per year)(Indicator 7.3.2).

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Increasing Forest Protection

While Ontario already conducts forest protection activities, opportunities may exist to increase the level of protection (e.g., increasing fire management efforts or more aggressive suppression of insect infestation and disease outbreaks). Minimizing the amount of natural disturbances may reduce the amount of carbon released to the atmosphere. Increased protection efforts could result in a shift to older forests creating a greater risk of major disturbance events.

Enhancing Stand Establishment and Tending

The intensification of forest management through enhanced stand establishment and tending practices could be used to increase the amount of carbon stored in forest stands and harvested wood products. Carbon storage could be increased by:

- Ensuring stands are quickly regenerated following harvesting or natural disturbance
- Using intensive renewal techniques such as planting or seeding
- Using tending to minimize competition
- Using genetically improved seed stock

These activities maximize stand stocking and accelerate growth to capture the full productive potential of the site.

Increasing the Use of Wood Products

Harvested wood products (paper, lumber, telephone poles, furniture, etc.) continue to store forest carbon outside the forest. Each wood product or end use has a unique carbon life cycle ending in the eventual release of carbon dioxide to the atmosphere. Policies that favour processing harvested wood into long-life cycle products expand the harvested wood product carbon pool. In most cases, using wood products as substitutes for more energy intensive building materials (e.g., steel, aluminum, and concrete), which generate large carbon dioxide emissions during their manufacture, significantly reduces greenhouse gas emissions.

Displacing Fossil Fuel Usage with Forest Biomass

In Ontario, forest biofibre refers to forest resources that are not normally used for conventional forest products. Forest biofibre includes tree tops, cull trees or portions of trees, unmerchantable and unmarketable trees, and trees that may be salvaged following a natural disturbance.

Burning forest biomass for energy emits the carbon dioxide captured and stored tree during growth. The next generation of trees subsequently captures and stores much of the carbon dioxide previously emitted from the processing and burning of biomass for energy. By contrast, when fossil fuels are burned for energy, carbon dioxide is added to the atmosphere. By using biomass energy instead of fossil fuels, the harvested wood does not become long-lived wood products (e.g. furniture and houses). However, it is unrealistic for all harvested wood biomass to be suited for use in long-lived wood products.

Research in Ontario suggests that due to the relatively slow growth rate of Ontario's forests it takes several decades before forest biomass burned in place of fossil fuels reduces net carbon dioxide emissions into the atmosphere. Any initiative to displace fossil fuels with forest biomass would need to consider the full life cycle emissions of both the biomass and the fossil fuel.

Climate Change

Additional Considerations

The *Crown Forest Sustainability Act* requires that Ontario's Crown forests be managed sustainably to conserve ecological processes and biological diversity. Many forest carbon mitigation strategies would rely on intensive forest management practices that may affect biodiversity, wildlife habitat, and other forest values. Intensive forest management activities also generally require the expenditure of more energy and therefore release more carbon dioxide than conventional forest management activities. These potential effects must be factored into forest management planning decisions about carbon mitigation strategies. In Ontario, forest sustainability takes priority over carbon mitigation strategies.

Carbon mitigation projects that involve enhanced forest management are not without risk. Carbon mitigation projects will be susceptible to the effects of rapid climate change, such as increased storm damage, forest wildfires, and insect and disease damage. The projects run the risk that carbon may be returned to the atmosphere due to natural disturbances. The risks need to be considered in the design and implementation of climate change mitigation projects.

Ontario is participating in the Western Climate Initiative. The initiative is working towards the creation of a market for carbon credits. Ontario has also announced the development of a cap and trade program. This would include the development of forest carbon offset protocols to support a cap and trade program. While some opportunities exist, Ontario's Crown forests are believed to have limited potential for formal carbon emission credits.

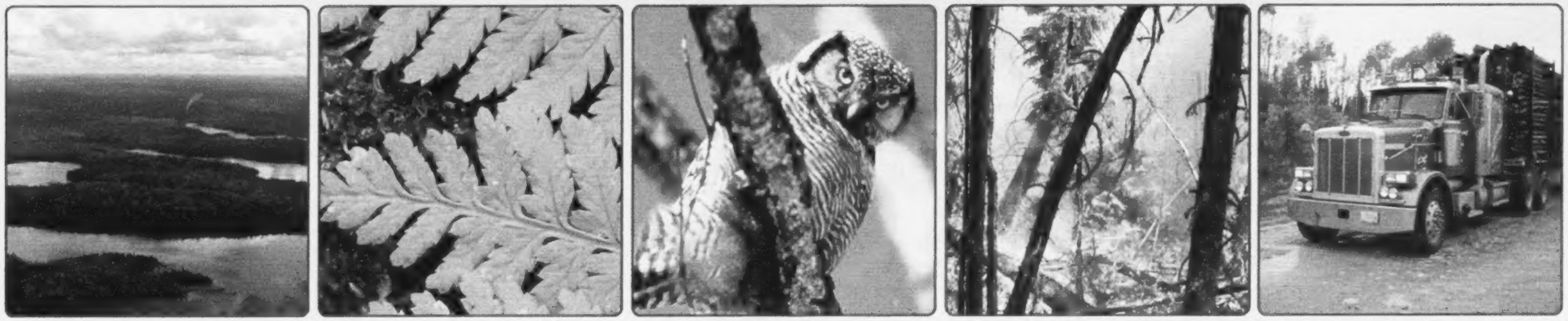
In order to ensure the future sustainability of Ontario's forests, climate change considerations must be considered in all policy and program decisions. This is expected to result in a shift in Ontario's approach to forest management planning. Forest management plans currently use historic forest information (e.g., disturbance regimes, growth rates, and natural succession) to set targets for future forest conditions. Climate change will result in future conditions that do not resemble those of the past, adding increased complexity to our predictions.

The *Forest Management Planning Manual for Crown Lands in Ontario* (FMPM) and the associated forest management guides provide the foundation for SFM. The FMPM includes a provision to consider climate change when developing the long-term management direction for a forest management plan. Incorporating considerations for climate change adaptation and mitigation into the forest management planning process will require new knowledge and appropriate forest modelling tools for forest practitioners. Research and science are crucial to the development of knowledge and tools for forest practitioners.

Summary

Climate change is expected to affect the composition, structure, and function of Ontario's forests. While changes in climate are not new to Ontario's forests, the current rate of change is expected to leave them ill-suited to adapting to climate change on their own. With the potential to act as large sources or sinks for carbon, Ontario's forests, like other forests around the world, can be used to increase carbon storage to reduce climate change. The MNR is currently examining several opportunities for Ontario's forests to adapt and possibly help to mitigate climate change.

Criterion & Indicator Summary



To assess the state of the forest, Ontario uses a hierarchical C&I framework for SFM. Criteria reflect provincial forest sustainability goals and are designed to reflect public values and long-term desired outcomes for Ontario's forests. Criteria are subdivided into elements. Each element conveys a specific objective that supports forest sustainability goals. Elements are composed of multiple indicators. Each indicator is a measurement tool used to assess progress towards the achievement of overall SFM goals and objectives. The SOF C&I framework includes seven criteria (e.g., Criterion 1: Conserving Biological Diversity), 23 elements (e.g., Element 1.1: Conserving Ecosystem Diversity), and 66 indicators (e.g., Indicator 1.1.1: Composition and Structure of Ecosystems).

Three basic types of information: environmental, social, and economic, are used in the SOF report. Environmental information is usually based on resource inventory surveys or research data. Most social and economic information is derived from census data and surveys of particular target groups (e.g., the forest industry or the general public).

Subject matter experts played an important role in this SOF report. Their expertise was used for analyzing and interpreting data, defining indicators of SFM, and evaluating indicator performance.

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Criterion & Indicator Summary

For each indicator, subject matter experts rated the state, trend, and adequacy of information, as follows:

- State: whether conditions identified by the indicator suggested good, mixed/fair, or poor progress towards SFM
- Trend: whether conditions were improving, mixed or showing no change, or deteriorating
- Data: whether the data (information) available for the indicator were adequate, partially adequate, or inadequate to support the indicator

An "unknown" rating was also available for all categories. Table 4 describes the symbols used to assess the state, trend, and data associated with each indicator.

State		Trend		Data	
Symbol	Meaning	Symbol	Meaning	Symbol	Meaning
▲+	Good	▲+	Improving	▲+	Adequate
+/-	Mixed or Fair Progress	+/-	Mixed or No Change	+/-	Partial
▼−	Poor	▼−	Deteriorating	▼−	Inadequate
◆?	Unknown	◆?	Unknown	◆?	Unknown

Table 4: Indicator condition ranking symbols used for reporting on state, trend, and data in the SOF report.

This section provides a high-level assessment of the seven criteria as defined by the C&I framework for SFM. For more detailed information, refer to the SOF C&I website available through the Ontario's Forests website.

National and International Context

In the early 1990s, a series of United Nations conferences and commissions defined SFM. It was agreed that a set of internationally accepted C&I would be developed for SFM. An international working group, known as the Montreal Process, was established to develop and implement the C&I for non-European boreal and temperate forests. The Montreal Process led to the endorsement of seven national criteria and associated indicators for reporting on progress towards the conservation and sustainable management of temperate and boreal forests.

In 1995, the Canadian Council of Forest Ministers developed a national framework of C&I for SFM based on the Montreal Process C&I.

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Criterion & Indicator Summary

Criterion 1: Conserving Biological Diversity

Biological diversity refers to the variety of life, as expressed through ecosystems, species, and genes that is shaped by ecological and evolutionary processes. Biodiversity is essential to human survival as it provides a wide range of ecosystem services. Biodiversity is assessed in Criterion 1 using information from three elements and nine indicators (Table 5). These indicator reports were used to support the biodiversity theme.

Collectively, the biodiversity indicators demonstrated that Ontario's forest ecosystems were stable. The state of eight of the nine indicators were assessed as being good or mixed/fair. While southern Ontario exhibited a trend towards smaller and more fragmented forests, forest fragmentation levels were stable in the area of the undertaking. The state of the invasive species indicator was assessed as poor. Invasive species continued to threaten Ontario's native species and pose a serious threat to biodiversity. New invasive species continued to be introduced into Ontario.

The trend in biological diversity was mostly mixed/no change with improvements in two indicators. The data were assessed as adequate for seven indicators and partially adequate for two.

Elements of Forest Sustainability	Indicator	State	Trend	Data
1.1 Conserving Ecosystem Diversity	1.1.1 Composition and Structure of Ecosystems	+	+/−	+
	1.1.2 Levels of Fragmentation and Connectedness of Forest Ecosystem Components	+	+/−	+
	1.1.3 Representation of Ecological Features by Protected Area Category	+/−	+	+/−
	1.1.4 Anthropogenic Corridors, such as Roads, Utility Corridors & Railways	+	+/−	+
1.2 Conserving Species Diversity	1.2.1 Forest-associated Species of Conservation Concern	+/−	+	+
	1.2.2 Provincially Featured and Monitored Forest-associated Wildlife Species	+/−	+/−	+/−
	1.2.3 Invasive Forest-associated Plant Species	−	+/−	+
1.3 Conserving Genetic Diversity	1.3.1 Genetic Diversity in Seed Orchards	+	+/−	+
	1.3.2 Tree Seed Collection and Use	+/−	+/−	+

Table 5: Condition of biological diversity indicators for Ontario's forests during the 2004 to 2008 reporting period.

Criterion & Indicator Summary

Criterion 2: Monitoring and Maintaining Forest Productivity and Resilience

Forest productivity can be expressed as the rate at which plants and animals are produced and maintained. Forest productivity is a reflection of how nutrients, water, and solar energy are used within an ecosystem. Forest resilience is the ability of components of a forested ecosystem to recover from, or adapt to, disturbances (e.g., harvest, wildfire, etc.). Forest productivity and resilience are assessed in Criterion 2 using information from three elements and ten associated indicators (Table 6). Several indicators related to this criterion were used to support the development of the forest health theme.

The state and trend of most forest productivity and resilience indicators was satisfactory (mixed/no change) or positive. The state and trend of forest disturbances, both biotic (insects and disease) and anthropogenic (forest harvest) was poor.

Harvest levels decreased significantly as a direct result of the economic downturn in the forest sector.

Elements of Forest Sustainability	Indicator	State	Trend	Data
2.1 Monitoring and Modeling Forest Productivity	2.1.1 Forest Growing Stock Indices	+/-	+/-	+/-
	2.1.2 Net Primary Productivity	+	+/-	+/-
2.2 Monitoring and Managing Incidences of Forest Disturbance	2.2.1 Fire and Weather Disturbance	+	+	+
	2.2.2 Biotic Disturbance - Insects and Disease	+/-	+/-	+
	2.2.3 Biotic Disturbance - Invasive Species	-	-	+/-
	2.2.4 Anthropogenic Disturbance (Forest Harvest)	-	-	+/-
2.3 Maintaining and Conserving Forest Ecosystem Resilience	2.3.1 Forest Renewal	+/-	+/-	+/-
	2.3.2 Structural Legacy Following Harvest	+	+/-	+/-
	2.3.3 Downed Woody Debris	+	+/-	+/-
	2.3.4 Logging Damage to Residual Trees and Renewal	+	+/-	+/-

Table 6: Condition of forest productivity and resilience indicators for Ontario's forests during the 2004 to 2008 reporting period.

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Criterion & Indicator Summary

In a managed forest with the suppression of natural disturbances (e.g., fires and insects), forest harvesting and the associated renewal activities are important to create forest conditions that emulate natural disturbances. Over the long-term, sustained shortfalls in harvest levels could affect the health of Crown forest ecosystems.

Although relatively low levels of native insects and disease outbreaks have been observed (in relation to the forest area disturbed), the number of invasive insect and disease species increased. Invasive species pose a serious risk to the sustainability of Ontario's forest resources.

Monitoring of harvest operations indicated that harvesting operations were being conducted according to guidelines. Forest renewal levels were consistent with the amount of forest area disturbed and 91% of the areas assessed were regenerated.

The data were adequate or positive for the indicators within this criterion; however a lack of statistical rigour and inconsistent renewal data collection were reported. Efforts to improve monitoring and modelling approaches are evolving. The forest resource inventory (FRI), which continued to be a significant data source for these efforts, was being updated to meet a new standard introduced in 2007.

Criterion & Indicator Summary

Criterion 3: Protecting and Conserving Ontario's Forest Soil and Water Resources

Soil and water conservation involves maintaining the quantity and quality of soil and water within, and flowing from, forested ecosystems. The primary focus for soil conservation is maintaining the living substrate for forest ecosystems. From a forestry perspective, the soil environment is the productive soil zone that physically sustains forest growth. The protection and conservation of soil and water resources is assessed in Criterion 3 using information from two elements and four indicators (Table 7).

The state and trend conditions for most of the forest soil and water indicators were adequate. To protect and conserve Ontario's forest soil and water resources, Ontario monitors compliance with forest soil protection guidelines as a component of minimizing the effects of forest management practices on Ontario's forest soil resources. Based on compliance reports, only a small percentage (between four and seven percent) of forest harvest operations resulted in soil site damage.

Increased operator training (e.g., identifying sensitive sites and proper implementation of best management practices) could further reduce the occurrence of site damage during harvesting and renewal activities.

Ontario monitors compliance with guidelines for protecting fish habitat as a component of minimizing the effects of forest management practices on water resources in forested catchments.

Elements of Forest Sustainability	Indicator	State	Trend	Data
3.1 Minimizing Effects of Forest Management Practices on Forest Soil Resources	3.1.1 Compliance with Forest Soil Protection Guidelines	+	+	−
3.2 Minimizing Effects of Forest Management Practices on Water Resources	3.2.1 Proportion of Watersheds with Stand-Replacing Disturbance	+/−	?	+/−
	3.2.2 Compliance with Forest Management Guidelines for Protecting Water Quality	+	+	−
	3.2.3 Compliance with Forest Management Guidelines for Protecting Fish Habitat	+	+	−

Table 7: Condition of forest soil and water resources indicators for Ontario's forests during the 2004 to 2008 reporting period.

Compliance reports suggest a high level of compliance with protecting fish habitat and water quality.

The data for most of the indicators were assessed as inadequate. Data quality limited the evaluation of many of the indicators, all of which are indirect or proxy indicators. Direct monitoring methods are too intensive and costly for operational-level monitoring. During the reporting period, no province-wide standards existed for evaluating soil and water conservation. Standards are now included in the *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales* (2010).

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Criterion & Indicator Summary

Criterion 4: Monitoring Forest Contributions to Global Ecological Cycles

Forests contribute to global ecological cycles by absorbing nutrients and releasing by-products. Climate change and global warming are expected to significantly affect Ontario's ecosystems and communities. The monitoring of forest contributions to global ecological cycles is assessed in Criterion 4 using information from three elements and ten associated indicators (Table 8). Several of the indicators related to this criterion were used to support the development of the climate change theme.

The state of seven of the ten indicators were assessed as being good or mixed/fair. From 2004 to 2008, several initiatives were implemented to contribute to Ontario's commitment to reduce the rate of global warming and the effects of climate change. The MNR has sponsored, co-sponsored, or participated in research to better understand the effects of climate change on the health of Ontario's ecosystems, communities, and people.

Elements of Forest Sustainability	Indicator	State	Trend	Data
4.1 Monitoring Forest Carbon Balance	4.1.1 Provincial Forest Carbon Balance	+	+	+/−
	4.1.2 Peatland Carbon Pools	+/−	?	−
	4.1.3 Monitoring Deforestation	−	−	+/−
	4.1.4 Monitoring Afforestation	−	+	+/−
4.2 Monitoring Forest Industry Sector Carbon Efficiency	4.2.1 Forest Biomass Utilisation for Fossil Fuel Substitution	+	+/−	+
	4.2.2 Carbon Dioxide Emissions Per Unit of Wood Produced	+	+/−	+
	4.2.3 Use of Recycled Versus Virgin Fibre	+/−	+/−	+
4.3 Monitoring Ecosystem Processes Contributing to Greenhouse Gasses	4.3.1 Monitoring Nitrogen Production	+	?	−
	4.3.2 Monitoring Environmental Sulphur	−	+	+/−
	4.3.3 Monitoring Evapotranspiration	+/−	+/−	+/−

Table 8: Condition of global ecological cycle indicators for Ontario's forests during the 2004 to 2008 reporting period.

Criterion & Indicator Summary

Researchers improved their understanding and estimates of forest carbon. Ontario's managed forests are expected to be a small carbon sink (storing or retaining more carbon then they release) over the next century. When wood products are factored into carbon estimates, Ontario's forests are expected to be a larger carbon sink. Continued changes in climate will affect future forest carbon stocks. Researchers are working to understand the extent of the effects and to determine effective mitigation methods. As scientific knowledge increases, forest managers will have a better understanding of how their management decisions affect forest carbon stocks.

The MNR is assessing the potential of Ontario's forests to help mitigate climate change and to adapt to climate change effects. The 50 Million Tree Program, discussed under the climate change theme, will contribute to mitigating climate change.

The forest industry increased the use of biomass energy in the production of forest products and initiated projects to convert forest biomass to biodiesel fuel. Since 1990, Ontario's pulp and paper producers and the wood products sector have substituted significant amounts of fossil fuels with wood wastes (e.g., sawdust, shavings, and off cuts bark). These fossil fuel substitutions along with equipment and process improvements resulted in reduced greenhouse gas emissions over the reporting period for both the pulp and paper and wood products manufacturing sectors.

Deforestation and afforestation levels were poor. In southern Ontario, conversion of productive forested land into agricultural or urban areas is common. Forest harvesting does not contribute to deforestation since harvested areas are regenerated. Unless they are rehabilitated when no longer in use, forest access roads may contribute to deforestation.

The introduction of the 50 Million Tree Program resulted in increased afforestation in southern Ontario by providing incentives for private landowners to return their land to forest.

The state of monitoring environmental sulphur was poor. The cumulative effects of acid rain continued to negatively affect Ontario's forests. More research and monitoring are needed to fully understand the effects of acid rain on SFM.

The data for most indicators were assessed as adequate or partially adequate. However, the quality and quantity of data available for monitoring the peatland carbon pool and nitrogen production indicators were assessed as needing improvement.

Criterion & Indicator Summary

Criterion 5: Providing a Stable Flow of Economic and Social Benefits from Ontario's Forests

Forests provide a range of societal benefits including commercial wood products, commercial and non-market goods and services, and social values (e.g., wildlife viewing, recreation, and aesthetics). Sustainable forest management requires that the forest continues to provide these goods and services over the long-term. Criterion 5 assesses the provision of a continuous and predictable flow of economic and social benefits from Ontario's forests using information from four elements and 15 indicators (Table 9). A number of indicators related to this criterion were used to support the development of the forest sector theme. The state of 10 of the 15 indicators were assessed as being good or mixed/fair. Indicators related to the amount of Crown forest area available for timber production, wildlife habitat, and wildlife population levels suggest that the productive capacity of Ontario's forests was being maintained. In addition to the economic and environmental benefits generated by the forest sector, Ontario's forests continued to provide a number of social benefits.

Table 9: Condition of economic and social benefits indicators for Ontario's forests during the 2004 to 2008 reporting period.

Elements of Forest Sustainability	Indicator	State	Trend	Data
5.1 Maintaining or Enhancing the Resource Productive Capacity of Ontario's Forest	5.1.1 Managed Crown Forest Area Available for Timber Production	+	+/−	+
	5.1.2 Habitat for Selected Wildlife Species	+/−	+/−	+
	5.1.3 Economic Benefits from Selected Wildlife Species (including fish)	+/−	+/−	+/−
	5.1.4 Sustainable Annual Removal of Forest Products	−	−	+
5.2 Monitoring and Supporting Forest Sector Employment, Investment, and Competitiveness	5.2.1 Rate of Return by Sector	+/−	+/−	+/−
	5.2.2 Trends in Forest-related Employment	−	−	+
	5.2.3 Capital and Repair Expenditures in Forest-resource-based Industries	+/−	−	+/−
	5.2.4 Investment in Research and Technology Development	+/−	−	−
5.3 Monitoring and Supporting Value Added Products and Services	5.3.1 Green GDP Related to Forest-resource-based Management Activities	+/−	+/−	−
	5.3.2 Trends in Value-Added Wood Products	−	−	+
	5.3.3 Trends in Value-Added Non-Timber Forest Resources	+	+/−	−
	5.3.4 Natural Capital Values	?	?	−
5.4 Maintaining or Enhancing Recreation, Tourism, and Other Social and Environmental Values Associated with the Forest	5.4.1 Old Growth	+	+/−	+
	5.4.2 Opportunities Available for Forest-based Recreation and Tourism	?	?	+/−
	5.4.3 Identification and Protection of Cultural and Heritage Resources	+	+	+/−

Criterion & Indicator Summary

The state and trend for the removal of forest products (including value added products) and forest sector employment indicators was assessed as poor and deteriorating. Ontario's forest sector was in a severe downturn for much of the 2004 to 2008 period.

Significant declines occurred in forest harvesting (which dropped to levels not seen since the early 1970s) and forest sector employment. While the forest sector's operating surplus declined sharply, the sector's operating surplus margin (a measure of the rate of return) remained more or less unchanged. The trend associated with industry expenditure and investment levels was in decline. Initiatives were being implemented by the Government of Ontario to help revitalize the forest sector to ensure it continues its important role in Ontario's economy. For more information, refer to the forest sector theme in this SOF report.

The state and trend for natural capital values and opportunities available for forest-based recreation and tourism were assessed as unknown.

Data were assessed as adequate or partially adequate for 11 of the 15 indicators within the criterion. The data quality for the remaining four indicators was assessed as inadequate.

Criterion & Indicator Summary

Criterion 6: Accepting Ontario's Social Responsibilities for Sustainable Forest Development

The concept of sustainable development transcends biological, ecological, and economic benchmarks. Ultimately it is about people; valuing people's input and the mechanisms that allow input to be provided. It includes effectiveness in managing resources in ways that accurately reflect social values; responsiveness to change as social values change; the special and unique needs of particular cultural and/or socioeconomic communities; and the extent to which the allocation of resources can be considered fair, equitable, balanced, and just.

Criterion 6 assesses the acceptance of social responsibilities for SFM using information from three elements and five indicators (Table 10).

The state and trend of four of the five indicators in this criterion were assessed as being good or mixed/fair. Ontario's forest decision-making processes rely on public and Aboriginal participation. The public and Aboriginal communities have been, and will continue to be, invited to be involved in the design of these processes.

Elements of Forest Sustainability	Indicator	State	Trend	Data
6.1 Respecting Aboriginal Peoples Rights and supporting Aboriginal Peoples Participation in Sustainable Forest Management Activities	6.1.1 Extent of Aboriginal Peoples' Participation in Forest Based Economic Opportunities	+/–	+/–	+/–
	6.1.2 Aboriginal Peoples' Participation in the Forest Management Planning Process	+/–	+	+/–
	6.1.3 Protection of Aboriginal Spiritual Values, Cultural Heritage, and Traditional Knowledge	+/–	?	+/–
6.2 Forest Community Wellbeing and Resilience	6.2.1 Resilience of Forest-based Communities	–	+/–	+
6.3 Maintaining Fair and Effective Public Participation in Sustainable Forest Management Decision-making	6.3.1 Fairness, Effectiveness, and Public Satisfaction with Decision-making Process Outcomes	+	+	+/–

Table 10: Condition of social responsibilities for sustainable development indicators for Ontario's forests during the 2004 to 2008 reporting period.

Criterion & Indicator Summary

From 2004 to 2008, the framework through which the public and Aboriginal communities provided input into the forest management planning process was maintained.

Opportunities for participation in the economic benefits associated with forests continued to be provided to Aboriginal communities and uptake of these opportunities by Aboriginal communities increased.

The Whitefeather Forest Initiative north of Red Lake is an example of one such opportunity. For more information on the Whitefeather Forest Initiative, refer to the SOF C&I website available on the Ontario's Forests website. Public participation processes used in forest management decision-making appeared to provide fair and effective opportunities for public participation. A survey of local citizens' committee members indicated general satisfaction with the forest management planning process and general agreement that forest management planning process outcomes were fair.

Opportunities existed to improve the involvement of the public and Aboriginal communities in providing input to SFM decision-making. There is an on-going need for further progress on implementing ways of achieving more equal participation by Aboriginal people in the economic benefits provided through forest management activities.

The state of the resilience of forest-based communities was ranked as poor. The number of communities in Ontario that depend on forests for economic stability remained unchanged during the reporting period. However, these communities remained susceptible to the cyclical nature of the forest industry, which experienced a major economic downturn for much of the 2004 to 2008 reporting period. Diversification of the economies in these communities may lead to improved resilience and a more stable socioeconomic situation.

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Criterion 7: Maintaining and Enhancing Ontario's Framework for Sustainable Forest Management

Ontario has developed a legislative, policy, and procedural framework to support SFM. The framework often operates outside of the forest, but it provides the operating environment, basic conditions, and processes through which SFM is delivered. Legislation, policy, and procedures direct MNR and MNR's business partners in administering SFM programs. Criterion 7 assesses Ontario's SFM framework using information from five elements and 13 indicators (Table 11). The five elements include the legal, institutional, economic, monitoring, and research and development frameworks in place for SFM.

The state and trend conditions for 11 of the 13 indicators in this criterion were assessed as being good or mixed/fair. The MNR maintained and enhanced an effective legislative and institutional framework during the SOF period.

Elements of Forest Sustainability	Indicator	State	Trend	Data
7.1 Maintaining and Enhancing Ontario's Legal Framework for Sustainable Forest Management	7.1.1 Changes in Laws, Policies, and Regulations	+	+	+
7.2 Maintaining and Enhancing Ontario's Institutional Framework for Sustainable Forest Management	7.2.1 Forest Management Work Force Competency	+	+/-	+
	7.2.2 Indicator Forest Access Roads	+/-	?	-
	7.2.3 Public Review and Consultation Infrastructure	+	+/-	+/-
7.3 Maintaining and Enhancing Ontario's Economic Framework for Sustainable Forest Management	7.3.1 Pricing System for Forest Products	+/-	+/-	+/-
	7.3.2 Private Land Forestry	+/-	+/-	+
7.4 Maintaining and Enhancing Ontario's Monitoring Framework for Sustainable Forest Management	7.4.1 Support Provided by Monitoring Programs for Forest Management	+/-	+/-	+/-
	7.4.2 Measuring Progress in Inventory and Monitoring Programs	+/-	+/-	+
	7.4.3 Investment in Forest-based Inventory and Monitoring	+/-	+/-	+/-
	7.4.4 Licensee Compliance with Provincial Forest Management Legislation, Policies and Guidelines	+	+	+/-
	7.4.5 Compliance Monitoring	+	+/-	+/-
7.5 Maintaining and Enhancing Ontario's Research and Development Framework for Sustainable Forest Management	7.5.1 Investments in Forest-Based Research and Development	+/-	+	+
	7.5.2 Investment in Forest-based Knowledge and Technology Transfer	-	-	+/-

Table 11: Condition of Ontario's framework for sustainable forest management indicators for Ontario's forests during the 2004 to 2008 reporting period.

Criterion & Indicator Summary

The MNR and its forest industry partners implemented strategies to ensure a competent workforce was in place to deliver a consistent and world class SFM framework. A good network of forest access roads existed that balanced the need for resource access while minimizing adverse impacts on other resources. Licensee compliance with provincial forest management legislation, policies, and guidelines improved both in terms of the compliance rate and reduced significance of non-compliant activities.

Ontario maintained a continuous five-year cycle of independent forest audits (IFA) with 48 IFAs conducted from 2004 to 2008. Audit results indicated that the majority of licensees (95%) were complying with SFM responsibilities, legislation, policy, and guides. However, auditors concluded that three forests were not being managed in compliance with the legislation, regulations, and policies in effect during the audit term. Examples of some of the issues that led auditors to the conclusions included: forecast declines in wildlife habitat, inaccurate yield curves, inadequate forest renewal, delays in addressing previous IFA findings, forest management planning problems, and annual report deficiencies. Action plans were developed to address the deficiencies. For more information on common IFA findings and what was being done to address them, refer to the SOF C&I website.

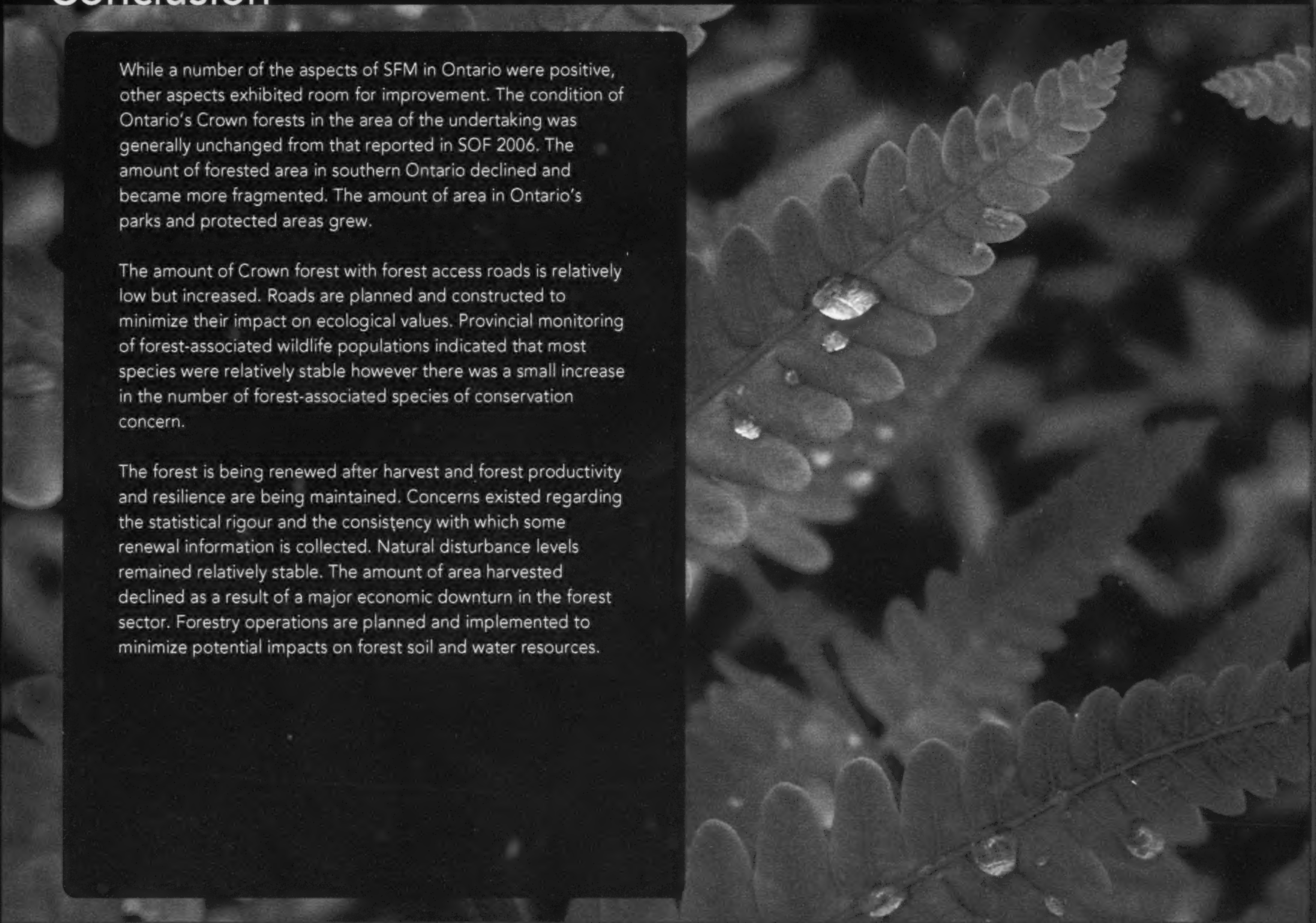
The MNR met all legally mandated inventory and monitoring program requirements. In some cases programs provided additional information that enhanced overall delivery.

The state for investments in forest-based knowledge and transfer was ranked as poor and the trend was ranked as deteriorating. The poor rankings were attributed to a decline in funding levels and a need to increase knowledge to address an increasing number of external factors that have the potential to impact forest resilience.

Considerable investment was made in understanding natural forest disturbance dynamics and determining how forest management guides should be changed to emulate natural disturbance to sustain ecosystem function, structure, and composition as required by the Crown Forest Sustainability Act. For additional information on research and other developments, refer to the annual reports on forest management for 2004 to 2008.

The data were assessed as adequate or partially adequate for most of the indicators with the exception of the forest roads access indicator. Some management units did not have up-to-date roads inventories, which resulted in data gaps.

Conclusion



While a number of the aspects of SFM in Ontario were positive, other aspects exhibited room for improvement. The condition of Ontario's Crown forests in the area of the undertaking was generally unchanged from that reported in SOF 2006. The amount of forested area in southern Ontario declined and became more fragmented. The amount of area in Ontario's parks and protected areas grew.

The amount of Crown forest with forest access roads is relatively low but increased. Roads are planned and constructed to minimize their impact on ecological values. Provincial monitoring of forest-associated wildlife populations indicated that most species were relatively stable however there was a small increase in the number of forest-associated species of conservation concern.

The forest is being renewed after harvest and forest productivity and resilience are being maintained. Concerns existed regarding the statistical rigour and the consistency with which some renewal information is collected. Natural disturbance levels remained relatively stable. The amount of area harvested declined as a result of a major economic downturn in the forest sector. Forestry operations are planned and implemented to minimize potential impacts on forest soil and water resources.

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Aboriginal participation in the forest management planning process and in forest-based economic opportunities was maintained. Room for improvement exists on implementing ways of achieving more equal participation by Aboriginal people in the benefits provided through forest management activities. The number of forest dependent communities remained stable but these communities are very susceptible to the cyclical nature of the industry.

The MNR developed and implemented an effective legislative and institutional framework for forest management that conserves ecosystem attributes over both short and longer time frames. The threat from invasive species (plant, insect, and disease) increased and impacted Ontario's forests. The trend is expected to continue given current levels of travel and commerce.

While the SOF criterion and indicator framework is not currently registering climate change impacts, climate change is expected to have major implications on Ontario's forests. Steps are being taken to help understand and adapt to the potential impacts of climate change on Ontario's forests and to identify how Ontario's forests can be used to mitigate climate change. The use of forest biomass to generate power is progressing and further opportunities are emerging that are expected to offset the use of fossil fuels.

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The economic benefits derived from Ontario's forests were in sharp decline. The forest sector experienced a major downturn which was amplified by the recent global economic downturn. The downturn has been hard on communities and has had a major negative impact on the achievement of sustainable harvest levels. Over time this could have an impact on forest health. A number of initiatives were implemented to help revitalize the forest sector and it appears the state of the forest sector is slowly beginning to improve.

Your feedback is appreciated. If you would like more detailed information or have any comments on the SOF report please email them to: sof.mnr@ontario.ca.

Please check the SOF C&I website periodically for updates as new data become available. The SOF C&I website is available through Ontario's Forests website. To receive email notifications of SOF updates please add your email address to our SOF distribution list by sending an email to: sof.mnr@ontario.ca.

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Indicator Web Site

All of the indicator reports used in the SOF report are presented on the SOF C&I website.

The SOF C&I website also contains additional background material including:

- An introduction to the C&I
- 7 criterion summary reports
- 26 element summary reports
- 66 indicator reports
- 17 measure reports
- Author and contributor biographies

Each indicator report has a "key facts" page that highlights the indicator condition and provides a brief summary of the report. Each report also includes background information, discussion, data, methods, and references to other reading.

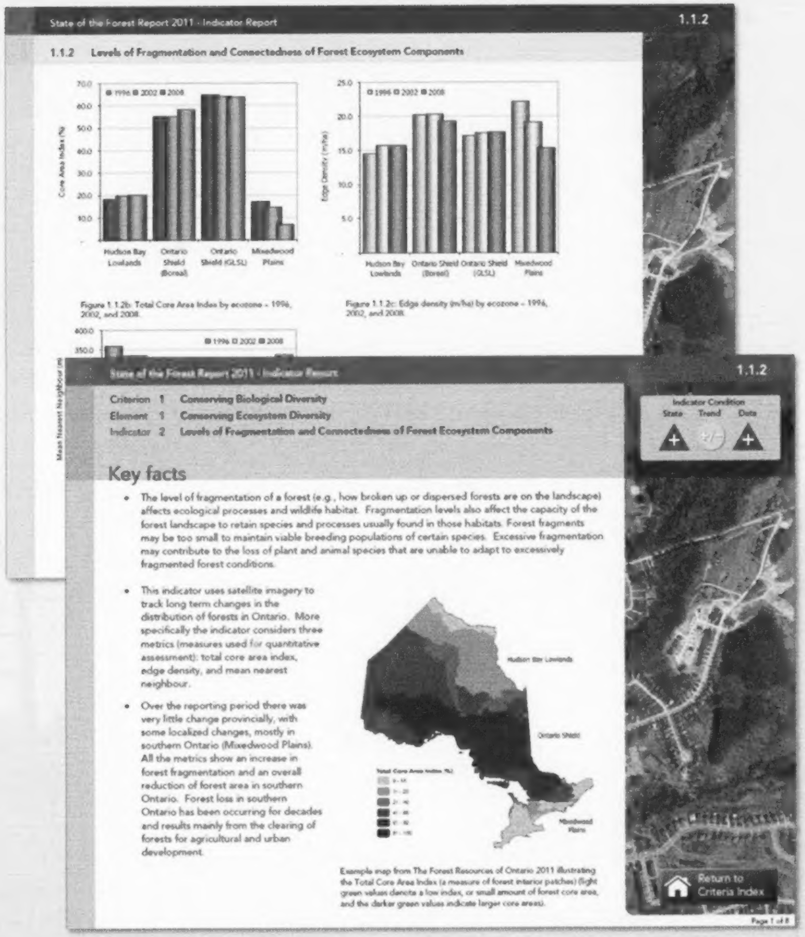
State of the Forest Report 2011 · Indicator Report
1.1.2
1.1.2 Levels of Fragmentation and Connectedness of Forest Ecosystem Components
Core Area Index (%)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
1996 2002 2008
Hudson Bay Lowlands
Ontario Shield (Boreal)
Ontario Shield (GLSL)
Mixedwood Plains
Edge Density (m/ha)
25.0
20.0
15.0
10.0
5.0
1996 2002 2008
Hudson Bay Lowlands
Ontario Shield (Boreal)
Ontario Shield (GLSL)
Mixedwood Plains
Mean Nearest Neighbour (m)
400.0
350.0
1996 2002 2008
State of the Forest Report 2011 · Indicator Report
1.1.2
Indicator Condition
State
Trend
Data
+
+/−
+
Hudson Bay Lowlands
Ontario Shield
Mixedwood Plains
Total Core Area Index (%)
Return to Criteria Index
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Figure 1.1.2b: Total Core Area Index by ecozone – 1996, 2002, and 2008.

Figure 1.1.2c: Edge density (m/ha) by ecozone – 1996, 2002, and 2008.

Criterion 1 Conserving Biological Diversity
Element 1 Conserving Ecosystem Diversity
Indicator 2 Levels of Fragmentation and Connectedness of Forest Ecosystem Components

Key facts

- The level of fragmentation of a forest (e.g., how broken up or dispersed forests are on the landscape) affects ecological processes and wildlife habitat. Fragmentation levels also affect the capacity of the forest landscape to retain species and processes usually found in those habitats. Forest fragments may be too small to maintain viable breeding populations of certain species. Excessive fragmentation may contribute to the loss of plant and animal species that are unable to adapt to excessively fragmented forest conditions.
- This indicator uses satellite imagery to track long term changes in the distribution of forests in Ontario. More specifically the indicator considers three metrics (measures used for quantitative assessment): total core area index, edge density, and mean nearest neighbour.
- Over the reporting period there was very little change provincially, with some localized changes, mostly in southern Ontario (Mixedwood Plains). All the metrics show an increase in forest fragmentation and an overall reduction of forest area in southern Ontario. Forest loss in southern Ontario has been occurring for decades and results mainly from the clearing of forests for agricultural and urban development.

Example map from The Forest Resources of Ontario 2011 illustrating the Total Core Area Index (a measure of forest interior patches) (light green values denote a low index, or small amount of forest core area, and the darker green values indicate larger core areas).

Figure 21: Images from the SOF C&I website.

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Glossary

This glossary provides definitions for key terms that appear in the text of the State of Ontario's Forests report. Sources are identified by abbreviation in parentheses following definitions. Where a definition has been listed in the glossary of the Forest Management Planning Manual for Ontario's Crown Forests (FMPM) as regulated under the Crown Forest Sustainability Act, 1994, the original source is omitted. Where a definition was modified or adapted from the indicated source, the source is prefaced with 'after'.

AFFORESTATION
The planting of trees on previously non-forested lands. (after Gleeson *et. al.*)

AREA OF THE UNDERTAKING
The area of Crown land on which forest management activities may be conducted in accordance with the requirements of Class EA Approval. (after FMPM). The area of the undertaking is depicted in Figure 1 of this SOF.

ARTIFICIAL REGENERATION
see Regeneration

CONIFER
- (1) Any of an order (Coniferales) of mostly evergreen trees and shrubs including forms (as pines) with true cones and others (as yews) with an arillate fruit. (FMPM)
- (2) (Needle-bearing trees that produce seeds in cones. (FMPM)

CROWN FOREST
A forest ecosystem or part of a forest ecosystem that is on land vested in Her Majesty in right of Ontario and under the management of the Minister of Natural Resources. (CFSA)

CROWN FOREST SUSTAINABILITY ACT (1994)
An Act of the Ontario legislature to provide for the sustainability of Crown forests and, in accordance with that objective, to manage Crown forests to meet social, economic, and environmental needs of present and future generations. (after CFSA)

CROWN LAND
Land vested in Her Majesty in right of Ontario. (FMPM)

DECIDUOUS
Trees typically belonging to the order Angiospermae with broad leaves that are usually shed annually (CCFM).

DEFORESTATION
The conversion of forested land to non-forest use.

DISTURBANCE
A significant change in the structure and/or composition of ecosystems, communities or populations through natural or human-induced events. (CCFM)

ECOLOGICAL LAND CLASSIFICATION (System)
- (1) A hierarchical approach to classifying land that is based on a consistent framework of landscape-scale through sitescale ecosystems by combinations of geologic, climatic, vegetative, soil, and landform features. (after FMPM).
- (2) An approach that attempts to identify ecologically similar areas. The system has seven hierarchical levels that are currently called, from largest to smallest: ecozone, ecoprovince, ecoregion, ecodistrict, ecosection, ecosite, and ecoelement. (after TELC).

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ECOSYSTEM
The sum of the plants, animals, environmental influences, and their interactions within a particular habitat. (FMPM)

ECOZONE
An ecological land classification unit, and the most general level. An area of the Earth's surface representing large and very generalized ecological units characterized by interacting abiotic and biotic factors. (after TELC)

FOREST COVER
All trees as described by the Forest Resources Inventory. (FMPM)

FOREST ECOSYSTEM
An ecosystem in which trees are, or are capable of, being a major biological component. (CFSA)

FOREST HEALTH
The condition of a forest ecosystem that sustains the ecosystem's complexity while providing for the needs of the people of Ontario. (CFSA)

FOREST INFORMATION MANUAL
A manual prepared under section 68 of the Crown Forest Sustainability Act and approved by the regulations, including amendments to the manual approved by the regulations. (CFSA)

FOREST RESOURCE INVENTORY
A survey of an area to determine such data as area, condition, timber, volume, and species, for specific purposes such as planning, purchase, assessment, evaluation, management, or harvesting. (FMPM)

GROWING STOCK
All the trees growing in a forest or in a specified part of it, generally expressed in terms of number or volume. (STC)

HARDWOOD
The wood of an angiospermous tree as distinguished from that of a coniferous tree. (FMPM)

INVASIVE SPECIES
Species that are not native to Ontario, that may threaten forest health, ecosystem function, or social and economic values. (after OMNR 2011)

LANDSCAPE
A heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout. (FMPM)
see also Ecological Land Classification

MANAGED FOREST
Crown forest for which there is no legal or land use planning decision which prevents the land from being managed for timber production. (FMPM)

MANAGEMENT UNIT
All or part of a Crown forest that has been designated as a management unit for the purposes of the Crown Forest Sustainability Act. (FMPM)

MATURE
In even-aged management, those trees or stands that are sufficiently developed to be harvestable and that are at or near rotation age (includes overmature trees and stands for which an overmature class has not been recognized). (STC)

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MIXEDWOOD(S)
A forest type in which 26-75% of the canopy is softwood. (FMPM)

NATURAL REGENERATION
see Regeneration

OLD GROWTH
A stand of mature or overmature trees relatively uninfluenced by human activity. (FMPM)

OLD GROWTH FORESTS

(1) Old growth forests are well past the age of maximum growth, frequently showing great horizontal and vertical density of structure and plant species composition, and possessing one or more features not seen in much younger forests such as snags, downed woody material, or arboreal lichens. (FMPM)
(2) Ecosystems characterized by the presence of old trees with their associated plants, animals, and ecological processes. They show little or no evidence of human disturbance. (FMPM)

PROTECTED AREAS
Areas such as provincial parks, federal parks, wilderness areas, ecological reserves, and recreation areas that have protected designations according to federal and provincial statutes. Protected areas are land and freshwater or marine areas set aside to protect the province's diverse natural and cultural heritage. (GOFT)

REGENERATION
The renewal of a forest, by natural or artificial means. The term may also be used to describe the young forest itself. (FMPM)

(1) Artificial Regeneration: Renewal of a forest by seeding or planting seedlings or cuttings. (FMPM)
(2) Natural Regeneration: Renewal of a forest, by natural seeding, sprouting, suckering or layering. (FMPM)

SILVICULTURE
Generally, the science and art of cultivating forest crops, based on a knowledge of silvics. More particularly, the theory and practice of controlling the establishment composition, constitution, and growth of forests. (FMPM)

SITE
An area considered in terms of environment, particularly as this determines the type and quality of the vegetation the area can carry. (FMPM)

SOFTWOOD(S)
Cone-bearing trees with needles or scalelike leaves belonging to the botanical group Gymnospermae. Also, stands of such trees and the wood produced by them. (FMPM)

SPECIES
A singular or plural term for a population or series of populations of organisms that are capable of interbreeding freely with each other but not with members of other species. (FMPM)

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SPECIES OF CONSERVATION CONCERN
A species that may become threatened or endangered because of biological characteristics or identified threats. Species of conservation concern are identified and tracked by the MNR's Natural Heritage Information Centre. (after OMNR 2009)

STAND
A community of trees possessing sufficient uniformity in composition, constitution, age, arrangement, or condition to be distinguishable from adjacent communities. (FMPM)

SUSTAINABLE FOREST MANAGEMENT
The management of forest ecosystems to maintain a healthy forest ecosystem which provides a continuous, predictable flow of benefits. Indicators of forest sustainability criteria are incorporated into strategic decision-making and into the periodic assessments of both forest and socio-economic conditions. Forest operations are conducted in a manner that conserve forest health and minimize undesirable effects on the physical and social environments. (FMPM)

VOLUME
(1) The amount of wood in a tree, stand, or other specified area, according to some unit of measurement or some standard of use. (FMPM)
(2) Gross merchantable volume: Volume of the main stem, excluding stump and top but including defective and decayed wood, of trees or stands. (FMPM)
(3) Gross total volume: Volume of the main stem, including stump and top as well as defective and decayed wood, of trees or stands. (FMPM)
(4) Net merchantable volume: Volume of the main stem, excluding stump and top as well as defective and decayed wood, of trees or stands. (FMPM)
(5) Mean Annual Increment: Average annual timber volume growth per unit area, for example, in cubic feet per year. Assuming even-aged management with clearcutting. (after FREF)

WETLAND
Land that is seasonally or permanently covered by shallow water, as well as land where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water-tolerant plants. The four major types of wetlands are swamps, marshes, bogs, and fens. (FMPM)

YIELD
The actual or estimated harvest of forest products over a given period of time. (FMPM)

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